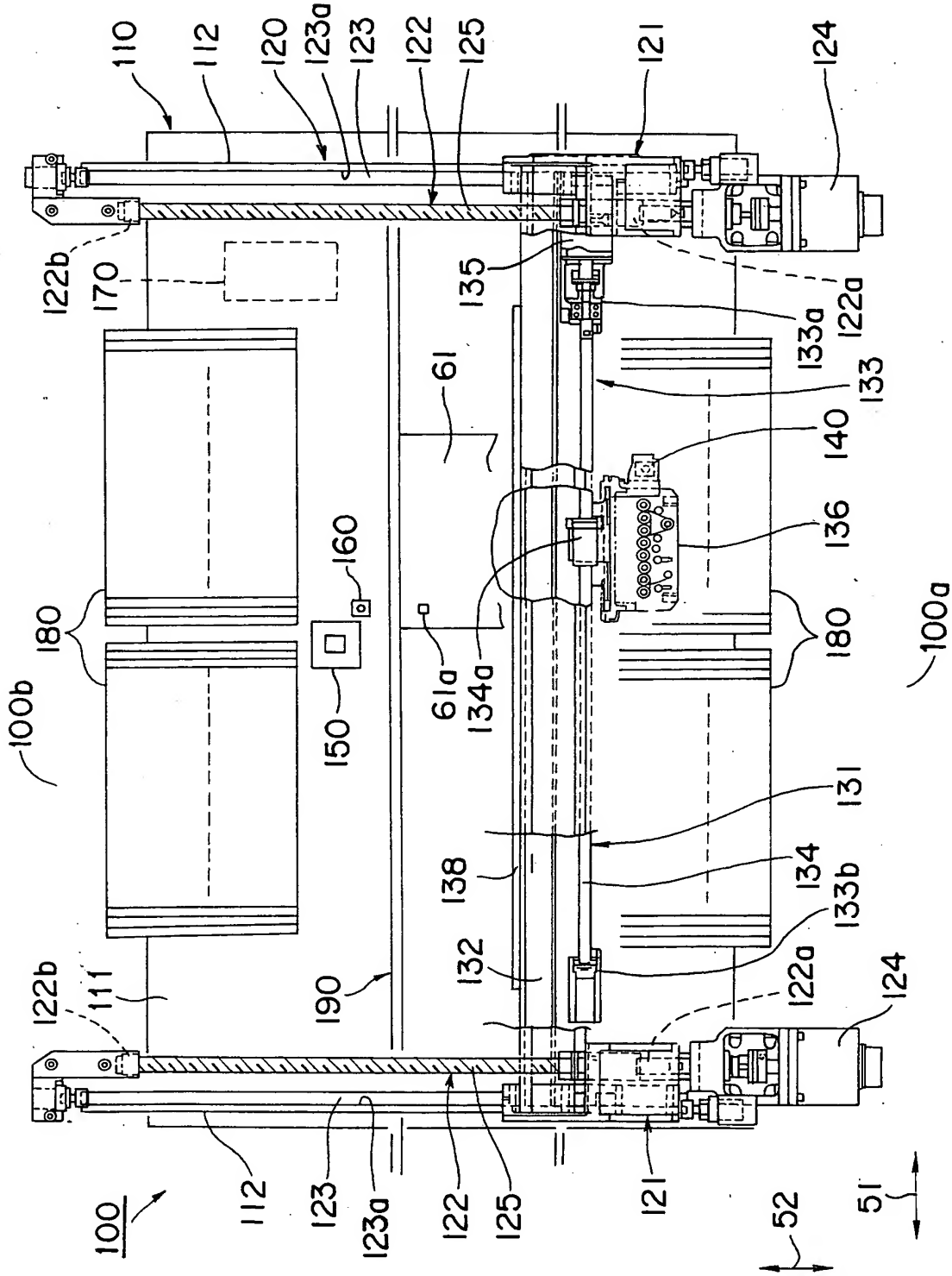

110
112
120
123a
123
122
125
121
124
122b
170
135
122a
133a
133
61
140
136
160
180
150
61a
134a
100b
100a
131
138
134
133b
132
111
190
100
52
51

Fig. 1

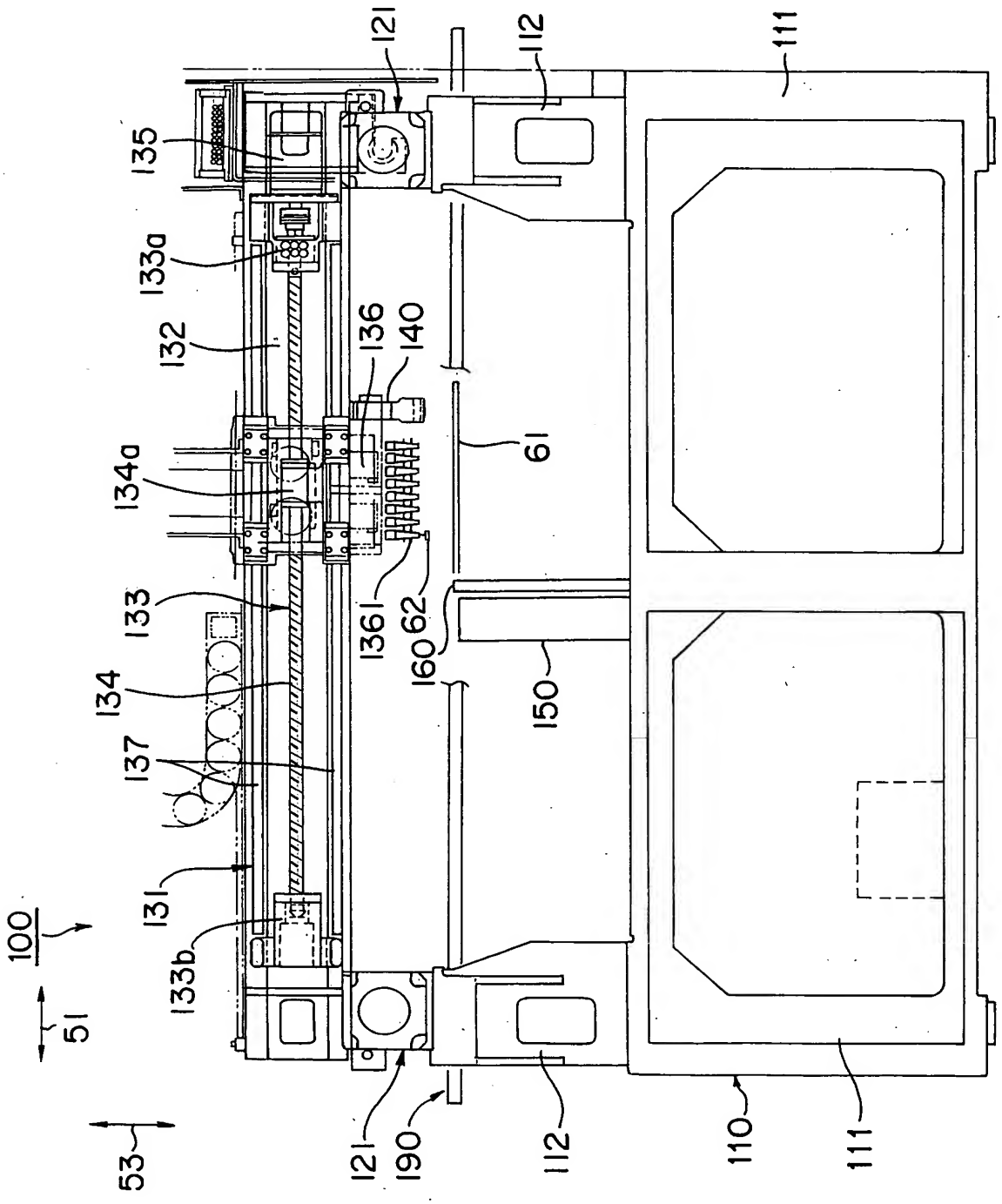

121
112
111
135
133a
132
136
140
134a
61
133
1361
62
160
134
150
137
131
133b
100
51
53
121
190
112
110
111

Fig. 2

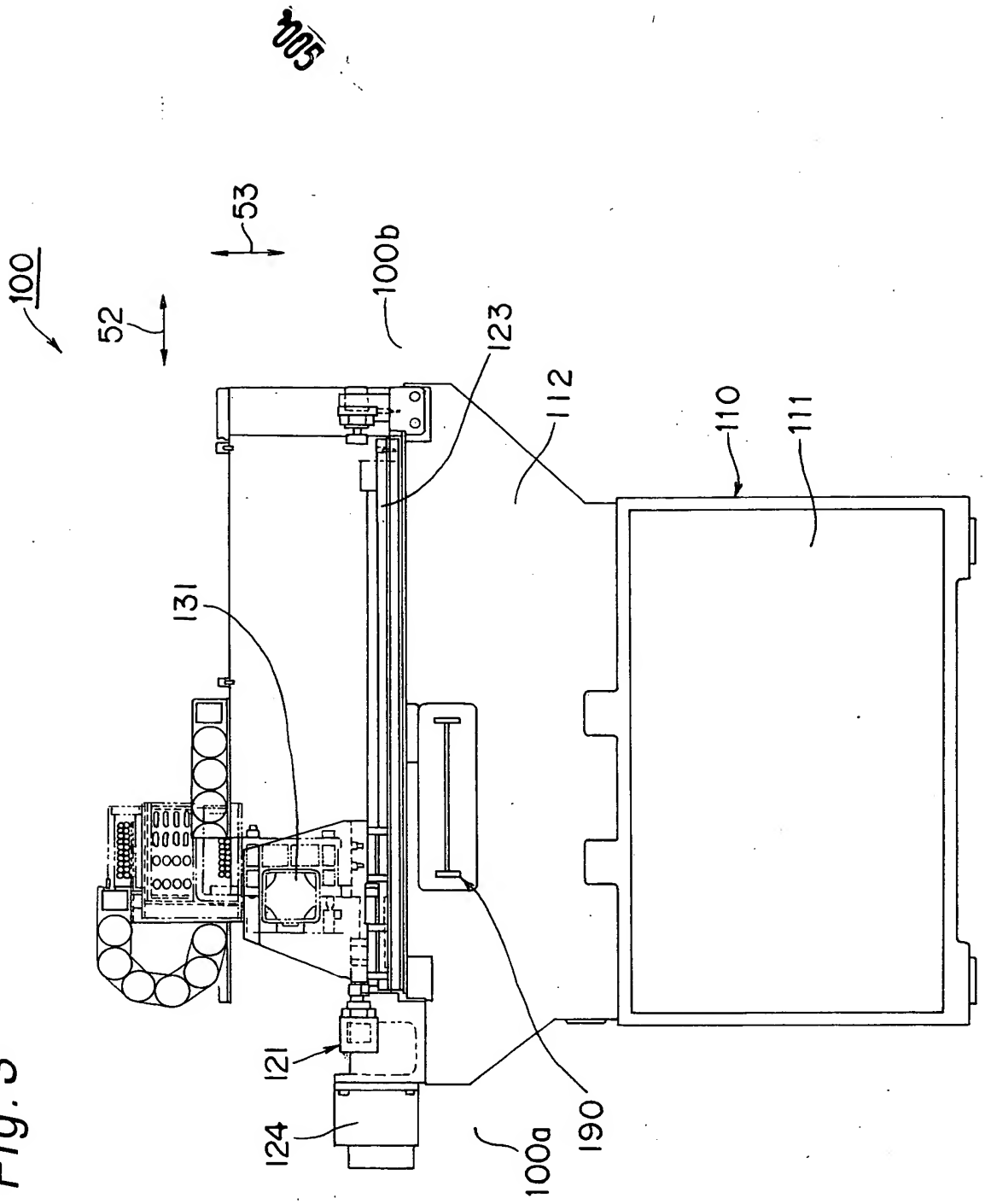


Fig. 3

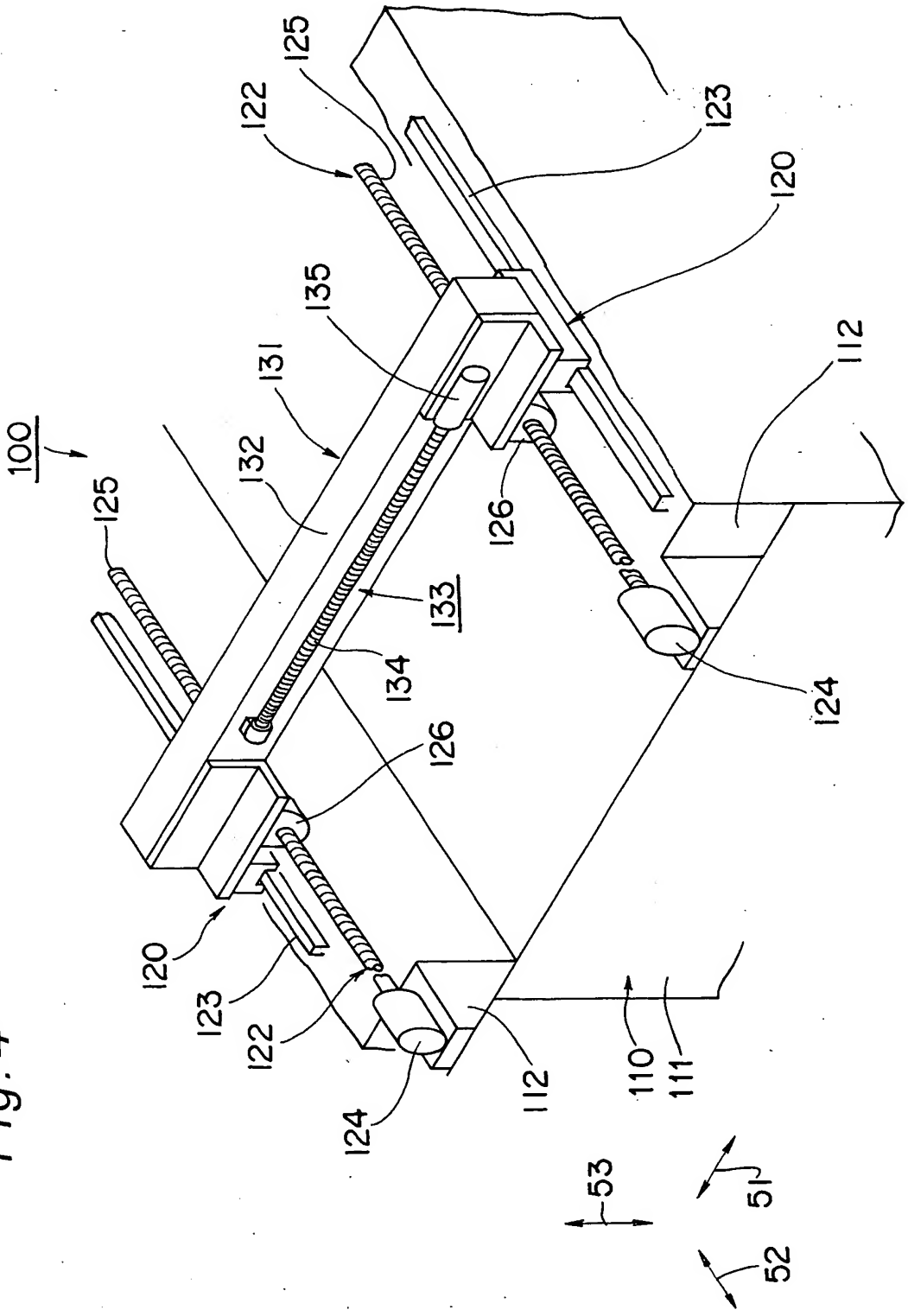

100
125
122
123
120
135
131
132
133
134
126
112
124
110
111
53
51
52

Fig. 4

Fig. 5

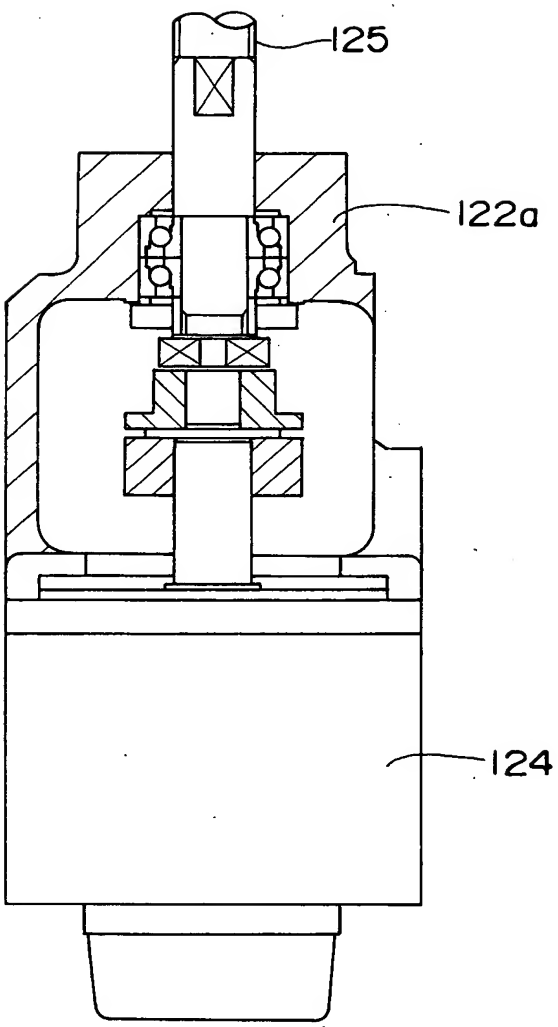


Fig. 6

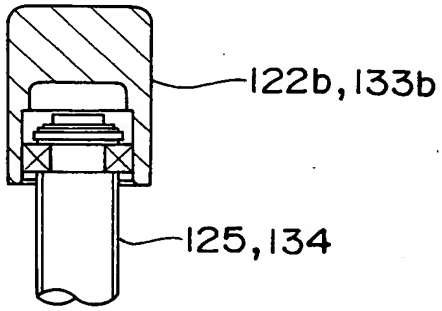


Fig. 7

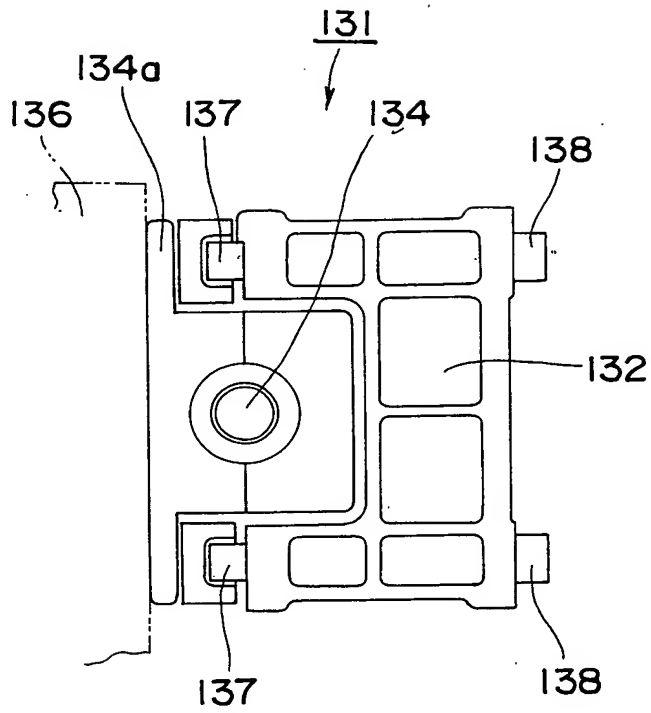


Fig. 8

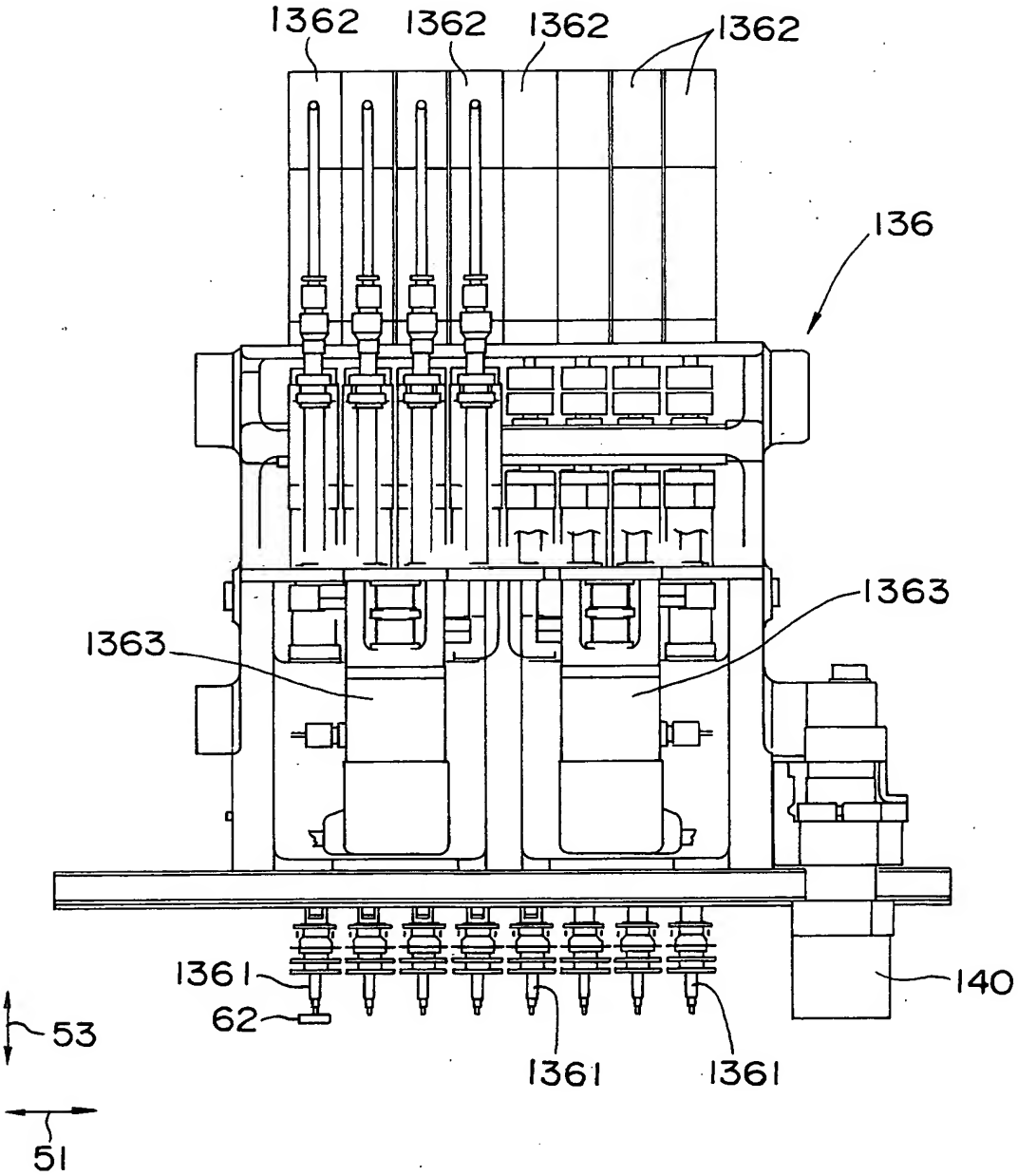


Fig. 9

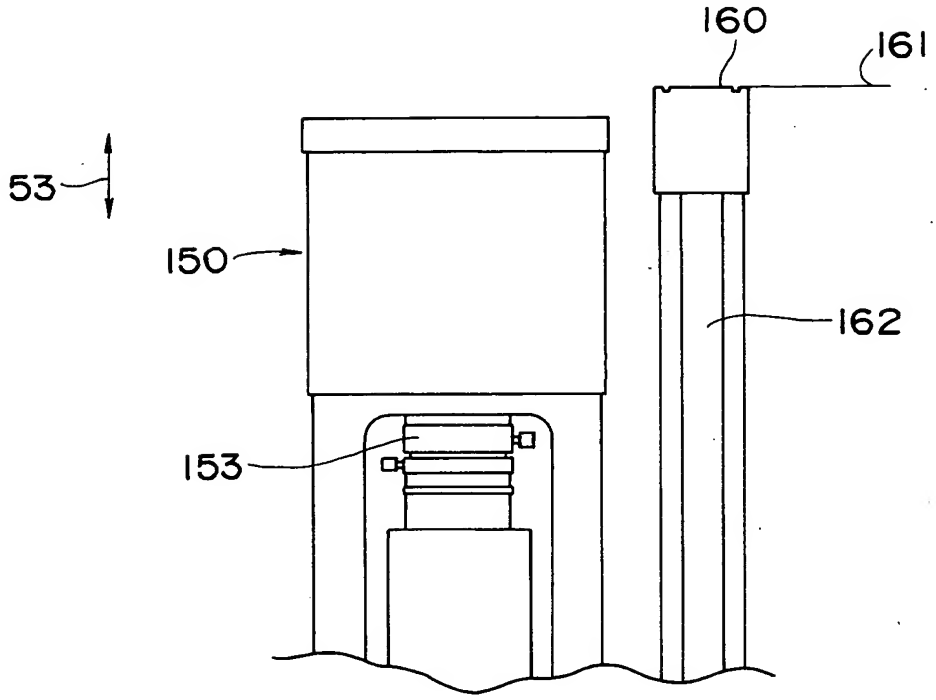


Fig. 10

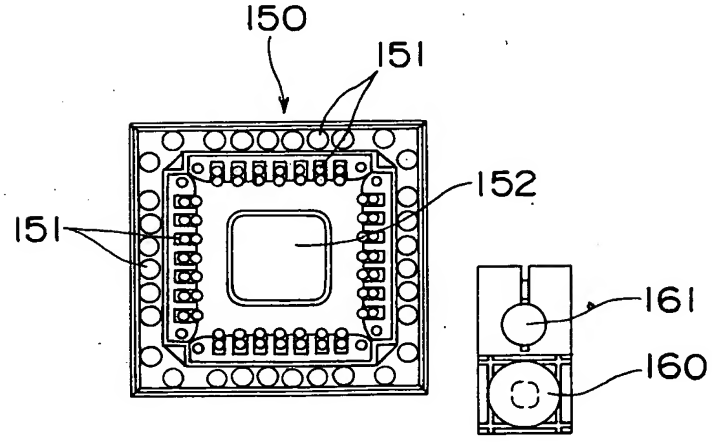


Fig.11

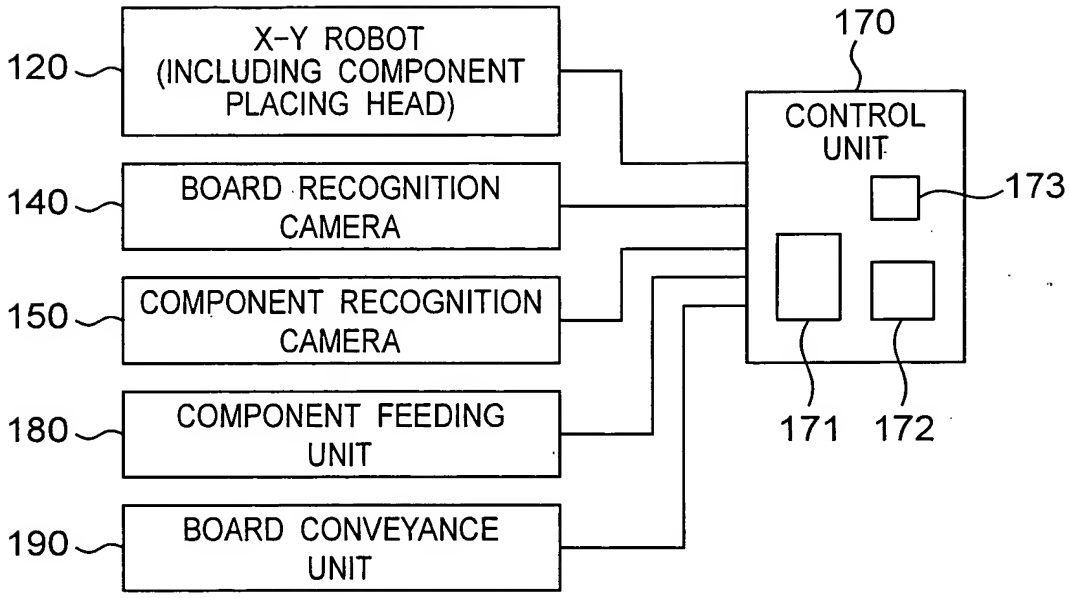

120
X-Y ROBOT (INCLUDING COMPONENT PLACING HEAD)
140
BOARD RECOGNITION CAMERA
150
COMPONENT RECOGNITION CAMERA
180
COMPONENT FEEDING UNIT
190
BOARD CONVEYANCE UNIT
170
CONTROL UNIT
173
171
172

Fig.12

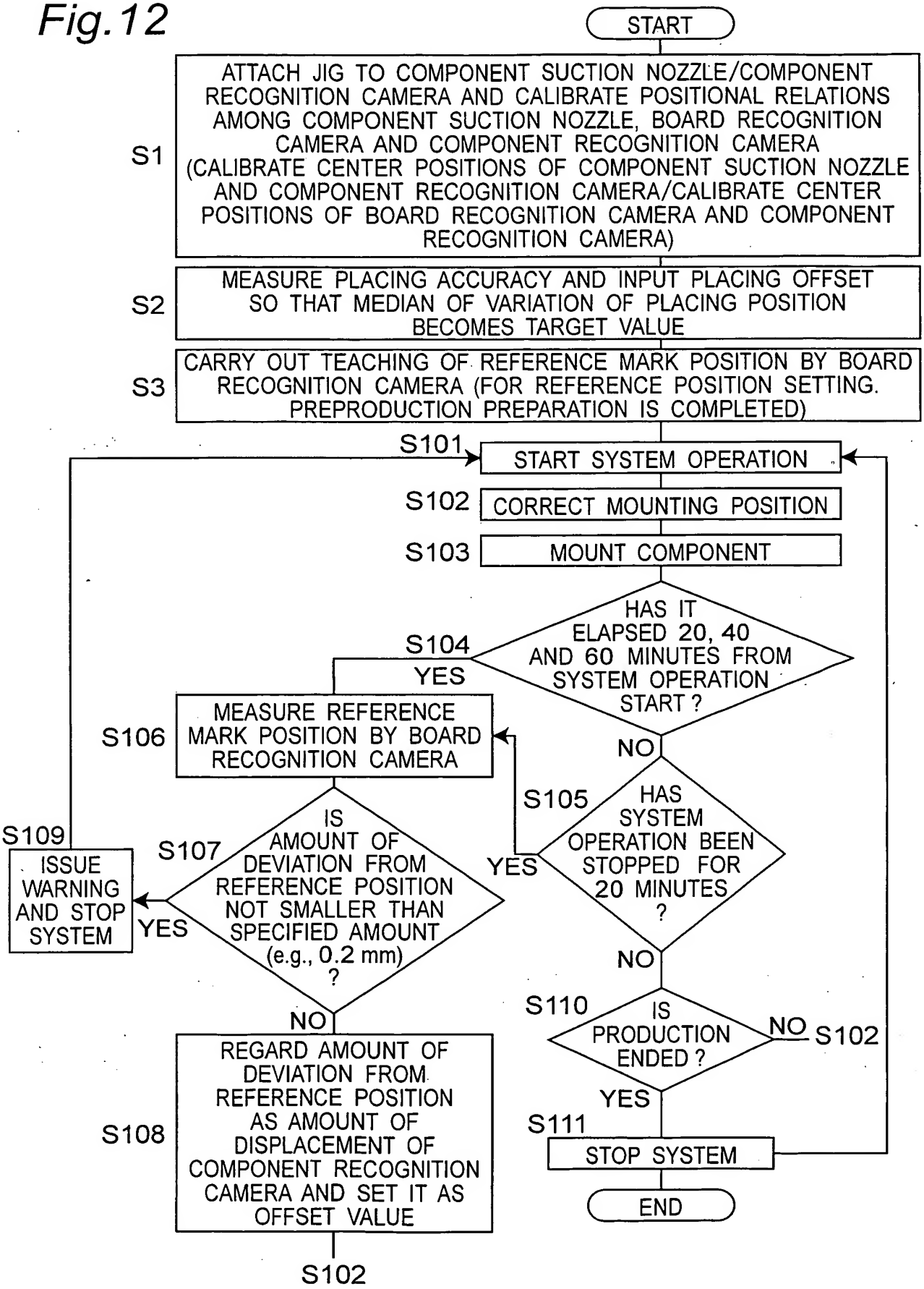

START
S1
ATTACH JIG TO COMPONENT SUCTION NOZZLE/COMPONENT RECOGNITION CAMERA AND CALIBRATE POSITIONAL RELATIONS AMONG COMPONENT SUCTION NOZZLE, BOARD RECOGNITION CAMERA AND COMPONENT RECOGNITION CAMERA (CALIBRATE CENTER POSITIONS OF COMPONENT SUCTION NOZZLE AND COMPONENT RECOGNITION CAMERA/CALIBRATE CENTER POSITIONS OF BOARD RECOGNITION CAMERA AND COMPONENT RECOGNITION CAMERA)
S2
MEASURE PLACING ACCURACY AND INPUT PLACING OFFSET SO THAT MEDIAN OF VARIATION OF PLACING POSITION BECOMES TARGET VALUE
S3
CARRY OUT TEACHING OF REFERENCE MARK POSITION BY BOARD RECOGNITION CAMERA (FOR REFERENCE POSITION SETTING. PREPRODUCTION PREPARATION IS COMPLETED)
S101
START SYSTEM OPERATION
S102
CORRECT MOUNTING POSITION
S103
MOUNT COMPONENT
S104
HAS IT ELAPSED 20, 40 AND 60 MINUTES FROM SYSTEM OPERATION START ?
YES
NO
S105
HAS SYSTEM OPERATION BEEN STOPPED FOR 20 MINUTES ?
YES
NO
S106
MEASURE REFERENCE MARK POSITION BY BOARD RECOGNITION CAMERA
S107
IS AMOUNT OF DEVIATION FROM REFERENCE POSITION NOT SMALLER THAN SPECIFIED AMOUNT (e.g., 0.2 mm) ?
YES
NO
S108
REGARD AMOUNT OF DEVIATION FROM REFERENCE POSITION AS AMOUNT OF DISPLACEMENT OF COMPONENT RECOGNITION CAMERA AND SET IT AS OFFSET VALUE
S109
ISSUE WARNING AND STOP SYSTEM
S110
IS PRODUCTION ENDED ?
NO
S102
YES
S111
STOP SYSTEM
END
S102

Fig. 13

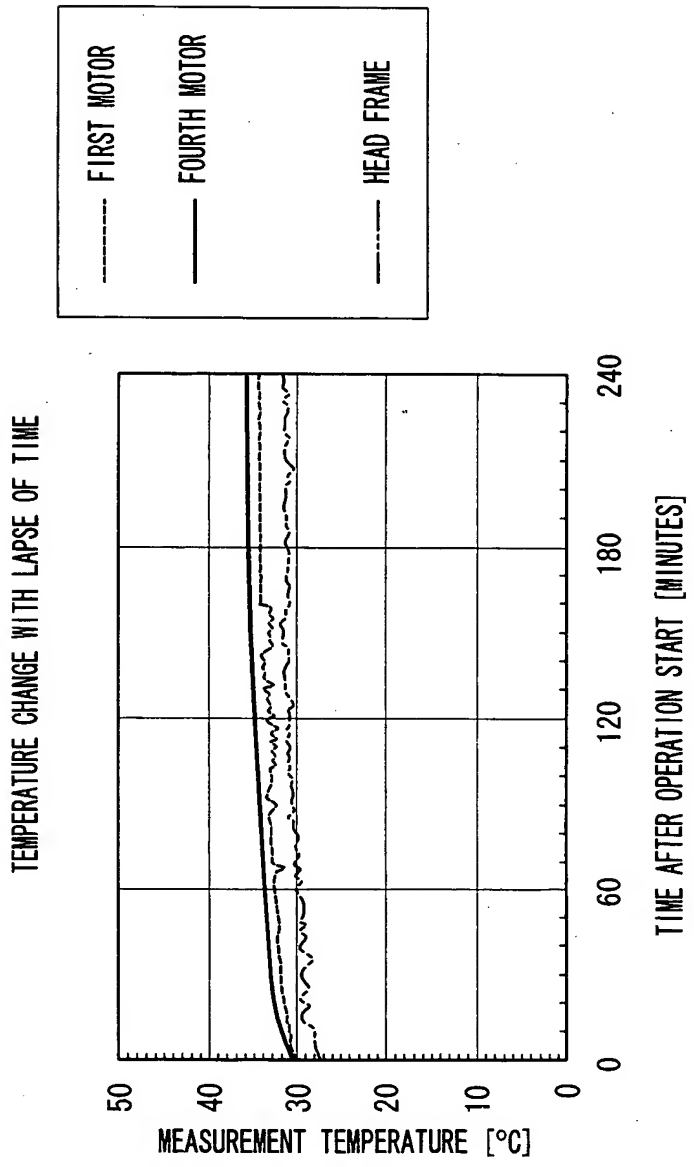

TEMPERATURE CHANGE WITH LAPSE OF TIME
FIRST MOTOR
FOURTH MOTOR
HEAD FRAME
MEASUREMENT TEMPERATURE [°C]
50
40
30
20
10
0
0
60
120
180
240
TIME AFTER OPERATION START [MINUTES]

Fig. 14

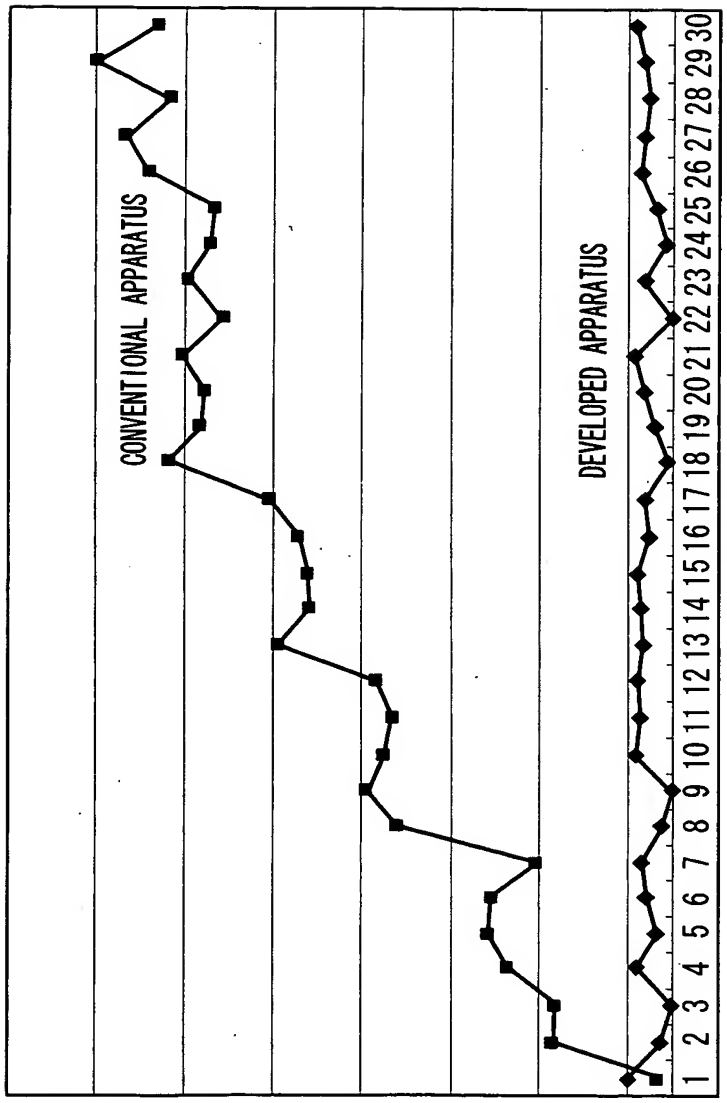

CONVENTIONAL APPARATUS
DEVELOPED APPARATUS
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
ELAPSE TIME [MINUTES]
AMOUNT OF CHANGE

Fig. 15

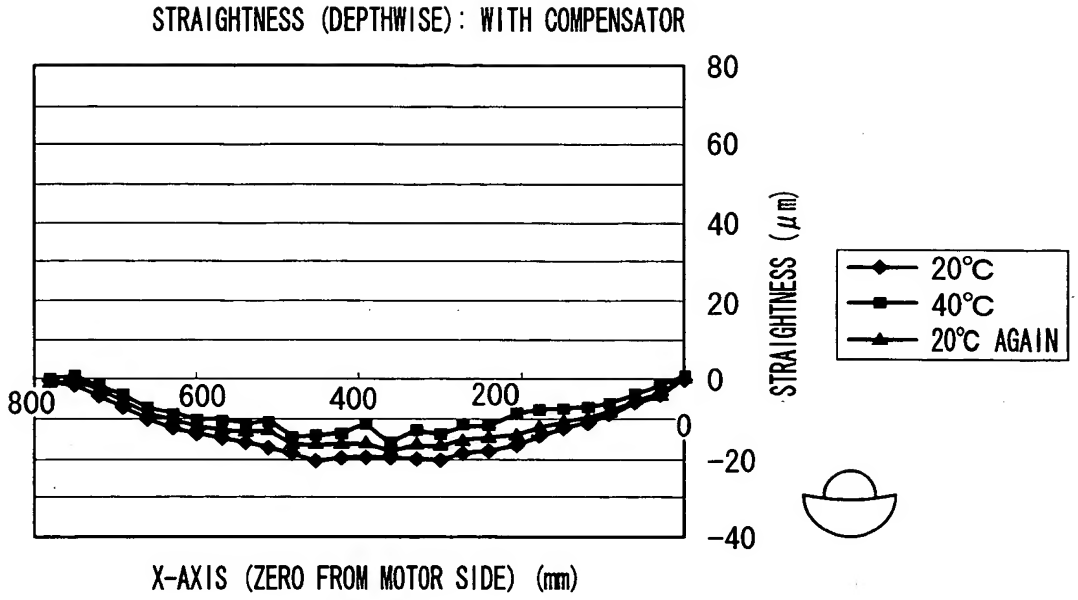

STRAIGHTNESS (DEPTHWISE): WITH COMPENSATOR
80
60
40
20
0
-20
-40
800
600
400
200
0
STRAIGHTNESS (μm)
20°C
40°C
20°C AGAIN
X-AXIS (ZERO FROM MOTOR SIDE) (mm)

Fig. 16

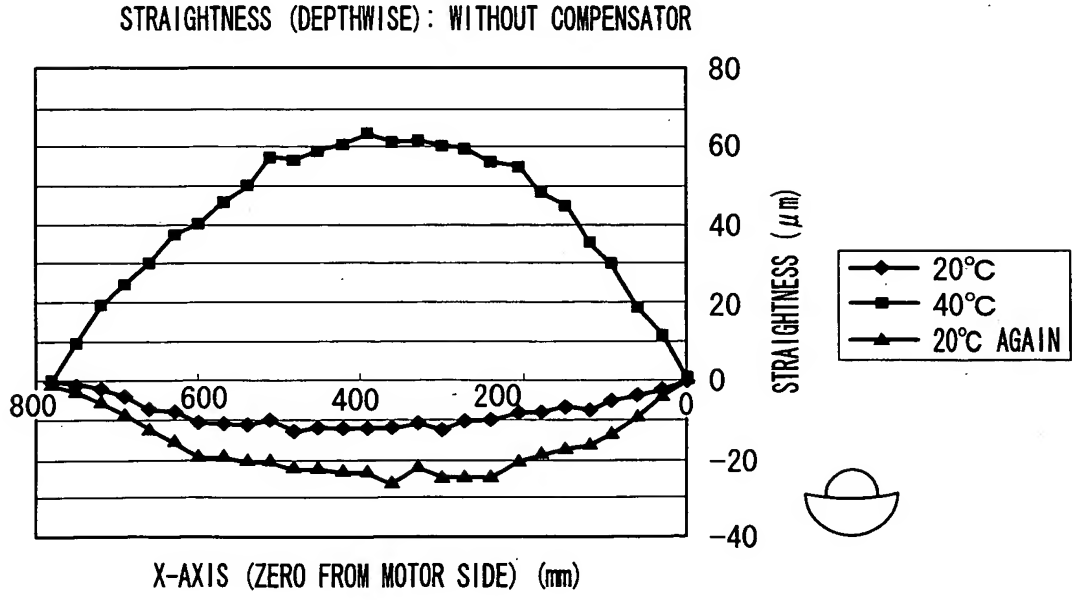

STRAIGHTNESS (DEPTHWISE): WITHOUT COMPENSATOR
80
60
40
20
0
-20
-40
800
600
400
200
0
STRAIGHTNESS (μm)
20°C
40°C
20°C AGAIN
X-AXIS (ZERO FROM MOTOR SIDE) (mm)

Fig. 17

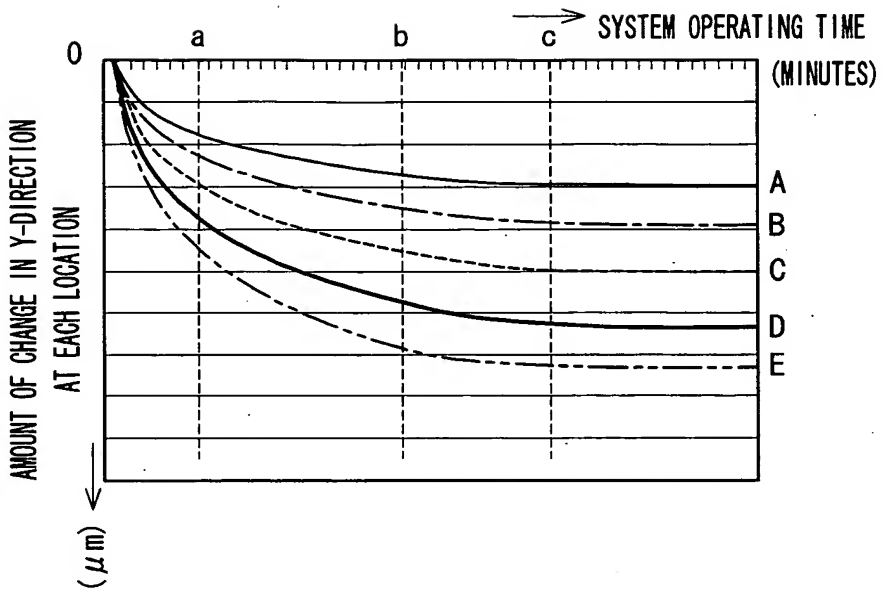

SYSTEM OPERATING TIME
(MINUTES)
0
a
b
c
A
B
C
D
E
AMOUNT OF CHANGE IN Y-DIRECTION AT EACH LOCATION
(μm)

Fig. 18

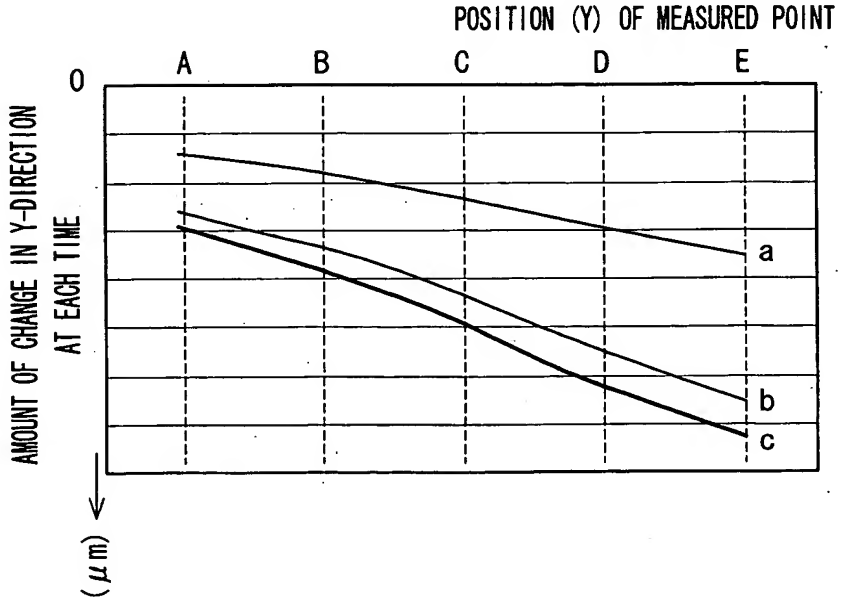

POSITION (Y) OF MEASURED POINT
0
A
B
C
D
E
a
b
c
AMOUNT OF CHANGE IN Y-DIRECTION AT EACH TIME
(μm)

Fig. 19

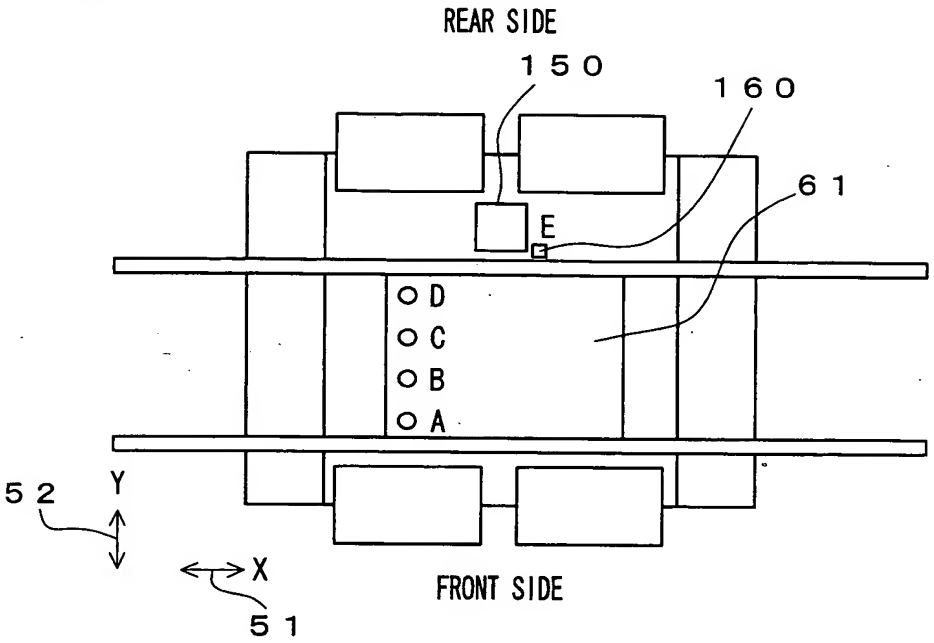

REAR SIDE
150
160
61
E
D
C
B
A
52
Y
X
51
FRONT SIDE

Fig. 20

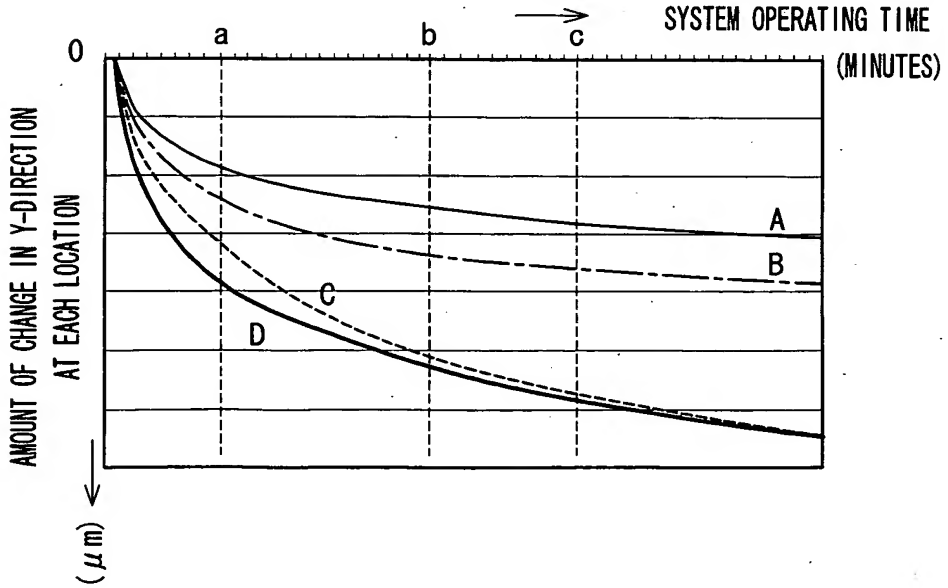

SYSTEM OPERATING TIME
(MINUTES)
0
a
b
c
A
B
C
D
AMOUNT OF CHANGE IN Y-DIRECTION AT EACH LOCATION
(μm)

Fig. 21

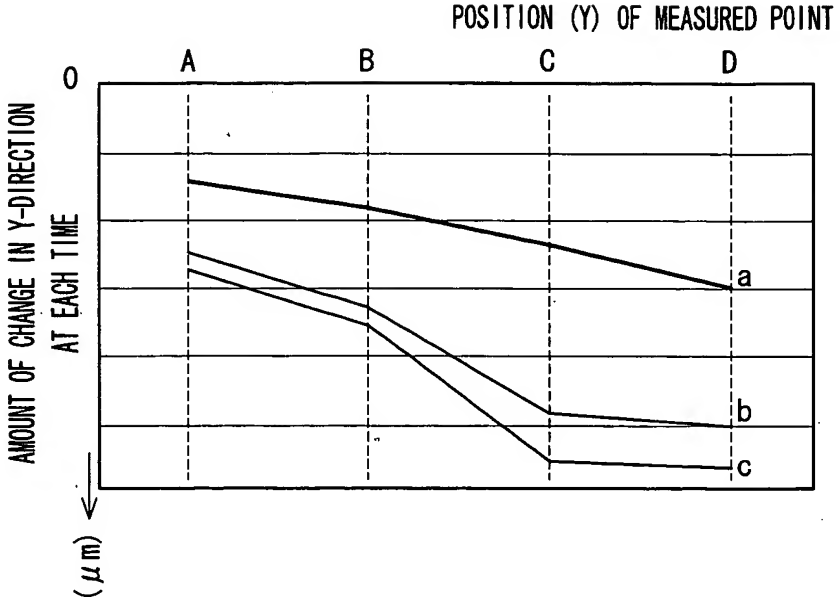

POSITION (Y) OF MEASURED POINT
A
B
C
D
0
AMOUNT OF CHANGE IN Y-DIRECTION AT EACH TIME
(μm)
a
b
c

Fig. 22

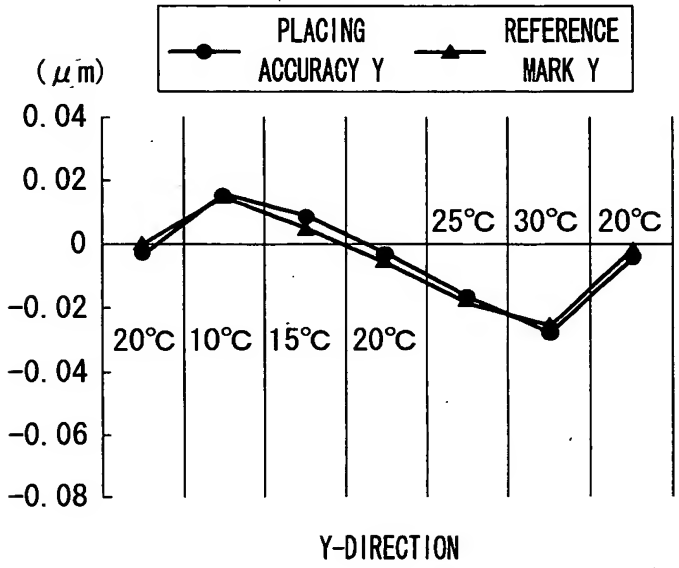

PLACING ACCURACY Y
REFERENCE MARK Y
(μm)
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
20℃
10℃
15℃
20℃
25℃
30℃
20℃
Y-DIRECTION

Fig. 23

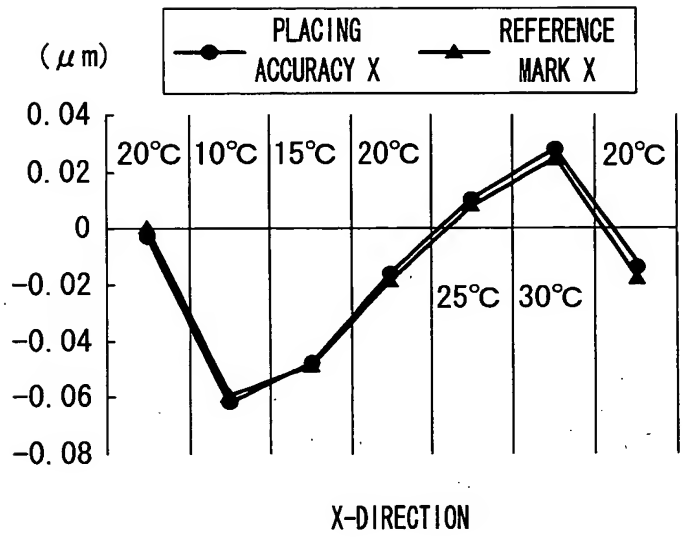

(μm)
PLACING ACCURACY X
REFERENCE MARK X
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
20℃
10℃
15℃
20℃
25℃
30℃
20℃
X-DIRECTION

Fig. 24

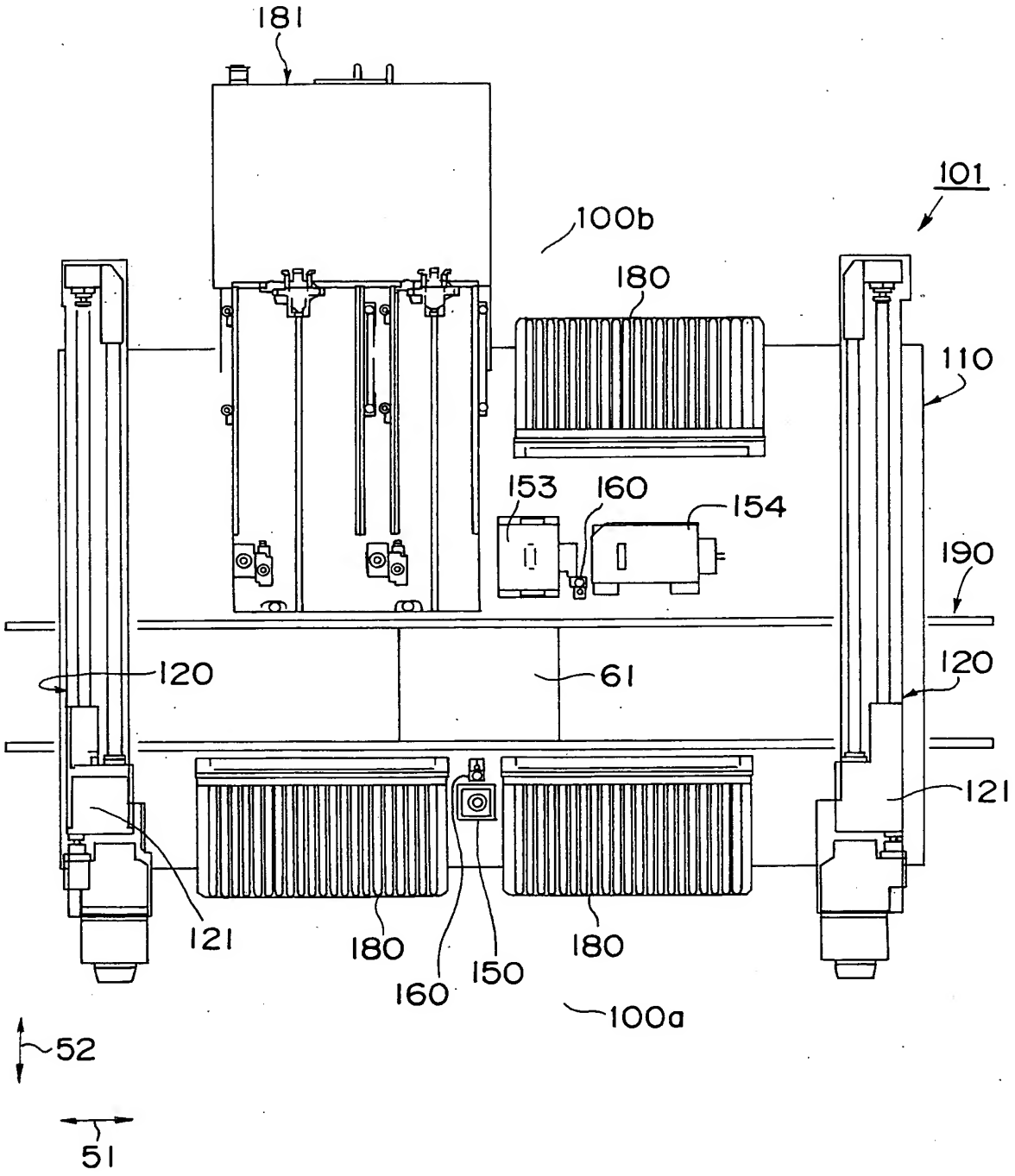

181
101
100b
180
110
153
160
154
190
120
61
120
121
121
180
160
150
180
100a
52
51

Fig. 25

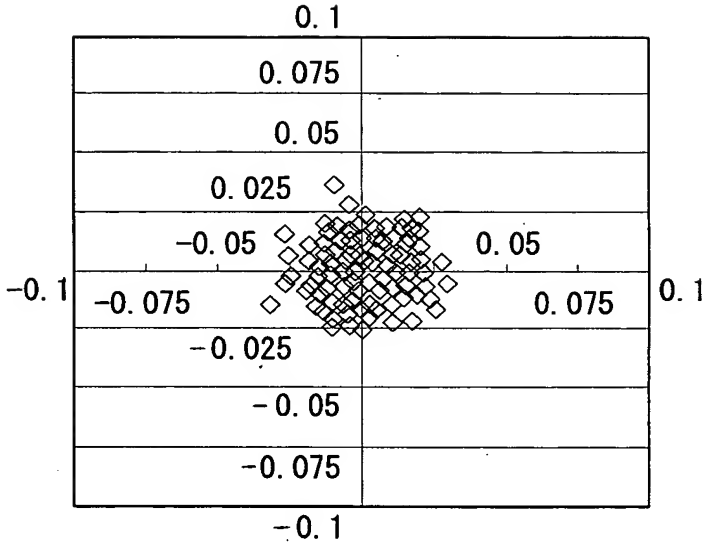

0.1
0.075
0.05
0.025
-0.05
0.05
-0.1
-0.075
0.075
0.1
-0.025
-0.05
-0.075
-0.1

Fig. 26

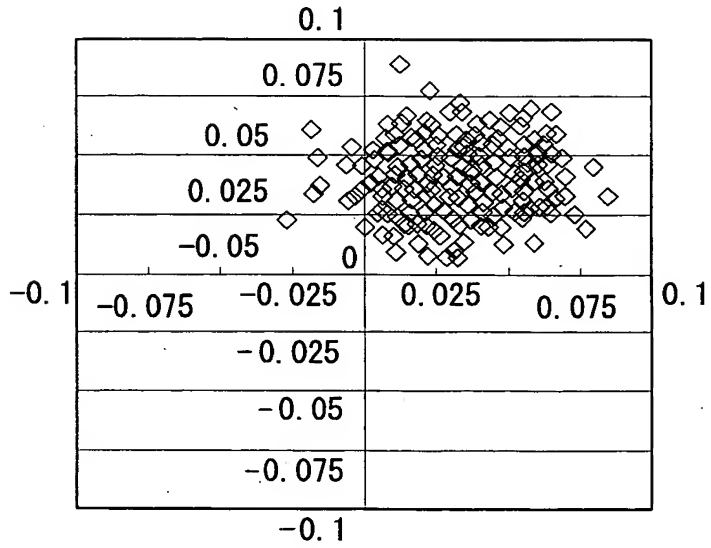

0.1
0.075
0.05
0.025
-0.05
0
-0.1
-0.075
-0.025
0.025
0.075
0.1
-0.025
-0.05
-0.075
-0.1

Fig. 27

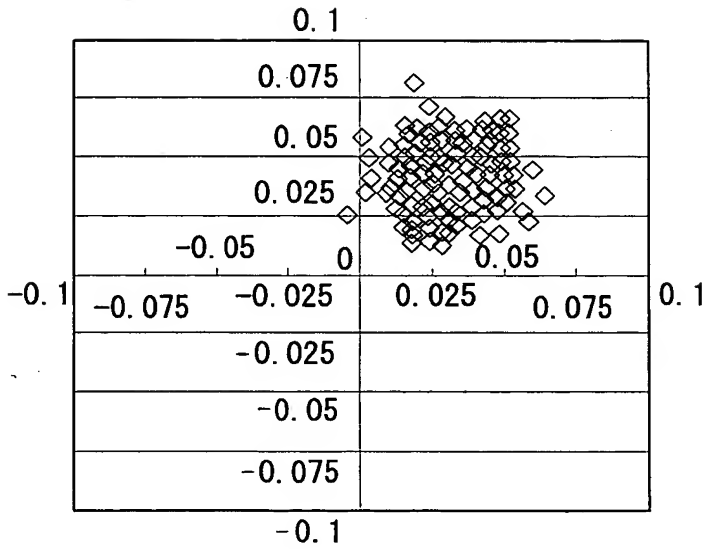

0.1
0.075
0.05
0.025
-0.05
0
0.05
-0.1
-0.075
-0.025
0.025
0.075
0.1
-0.025
-0.05
-0.075
-0.1

Fig. 28

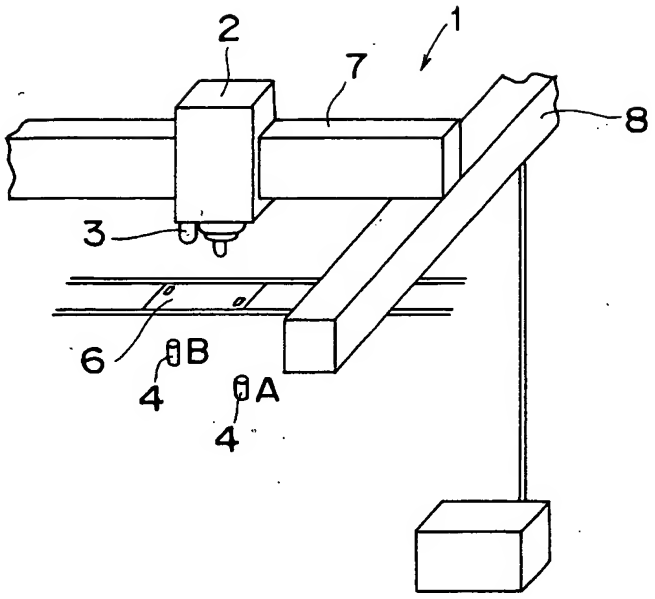


Fig. 29

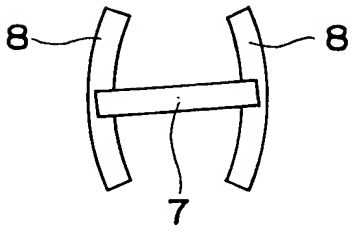
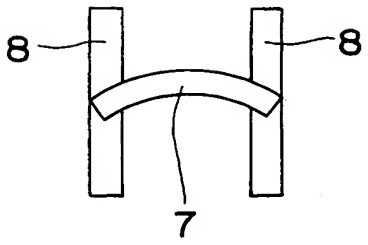


Fig. 30



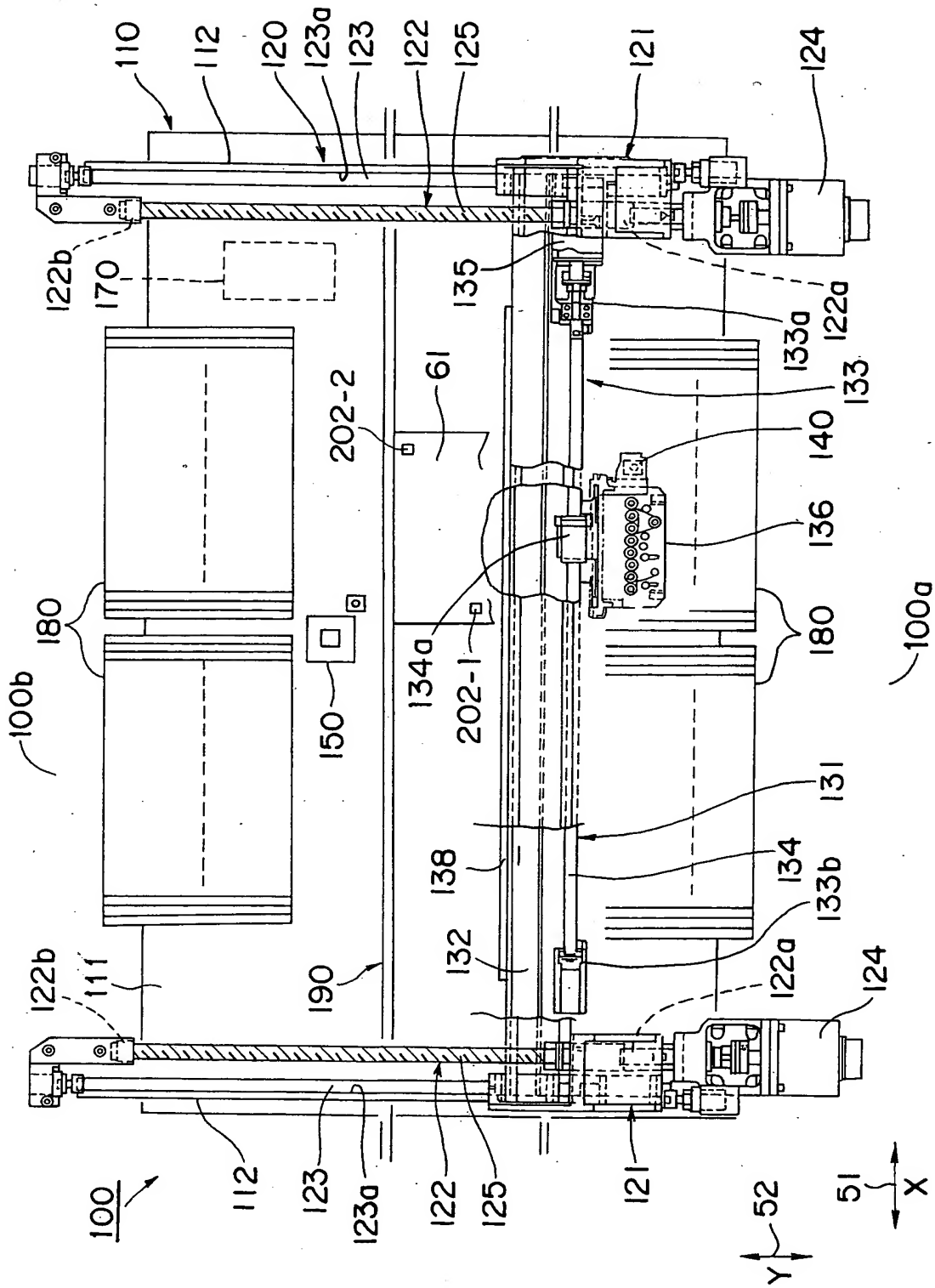

110
112
120
123a
123
122
125
121
124
122b
170
135
122a
133a
133
61
202-2
140
136
180
100b
150
134a
202-1
100a
131
138
134
133b
132
190
111
122b
122a
124
112
123
123a
122
125
121
100
51
X
52
Y

Fig. 31

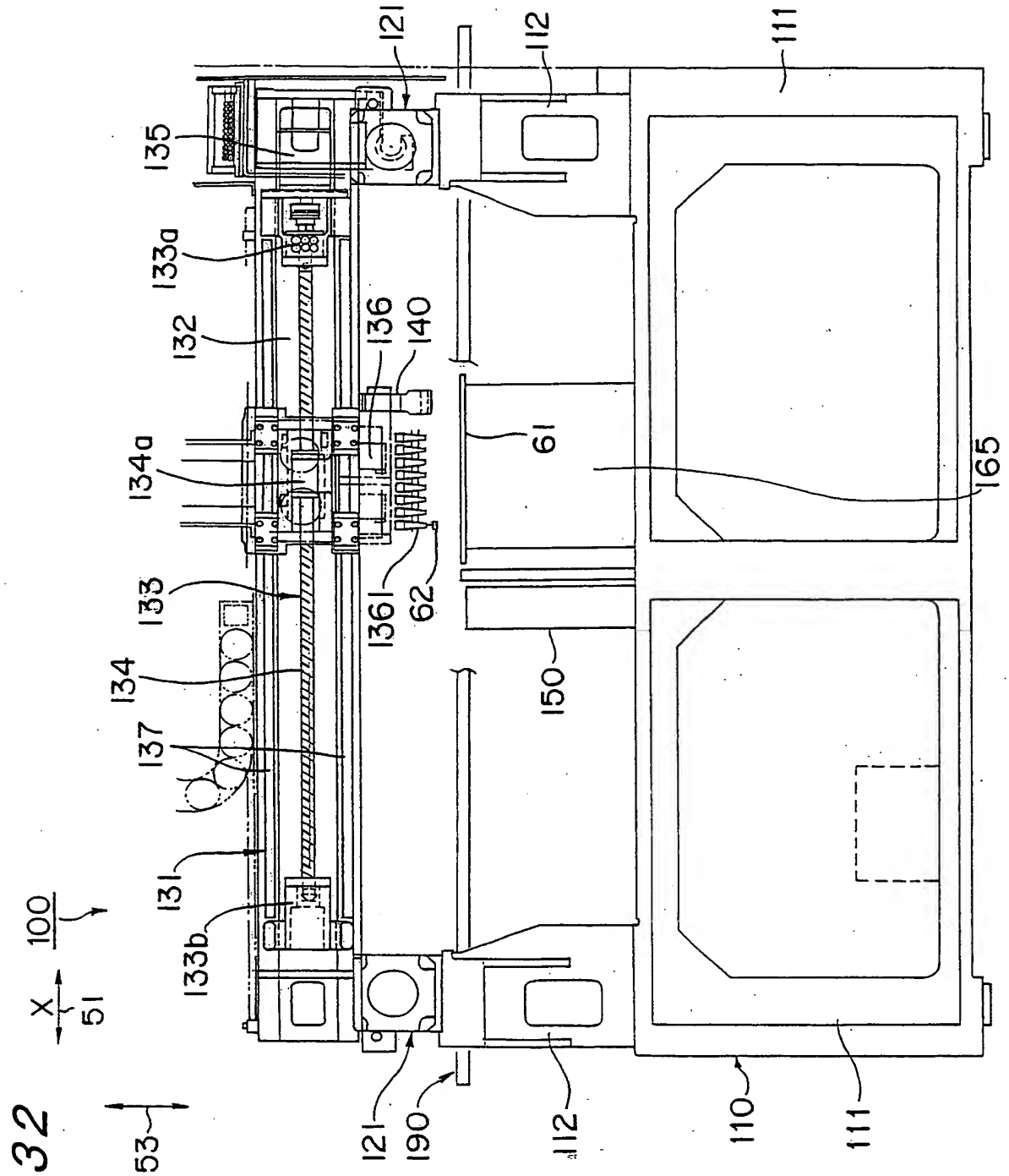

121
112
111
135
133a
132
136
140
134a
61
165
133
1361
62
134
150
137
131
133b
100
X
51
53
121
190
112
110
111

Fig. 32

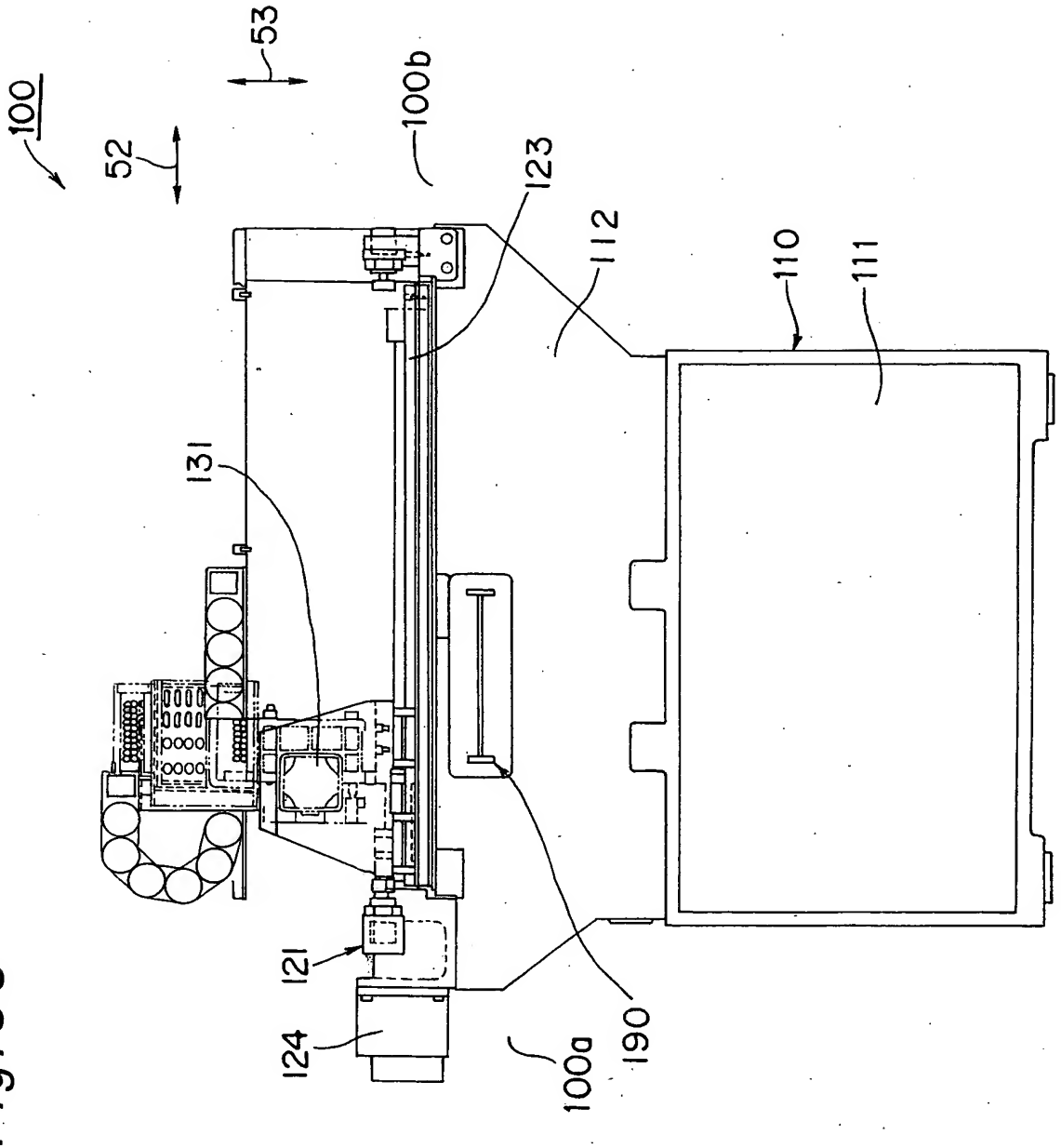


Fig. 33

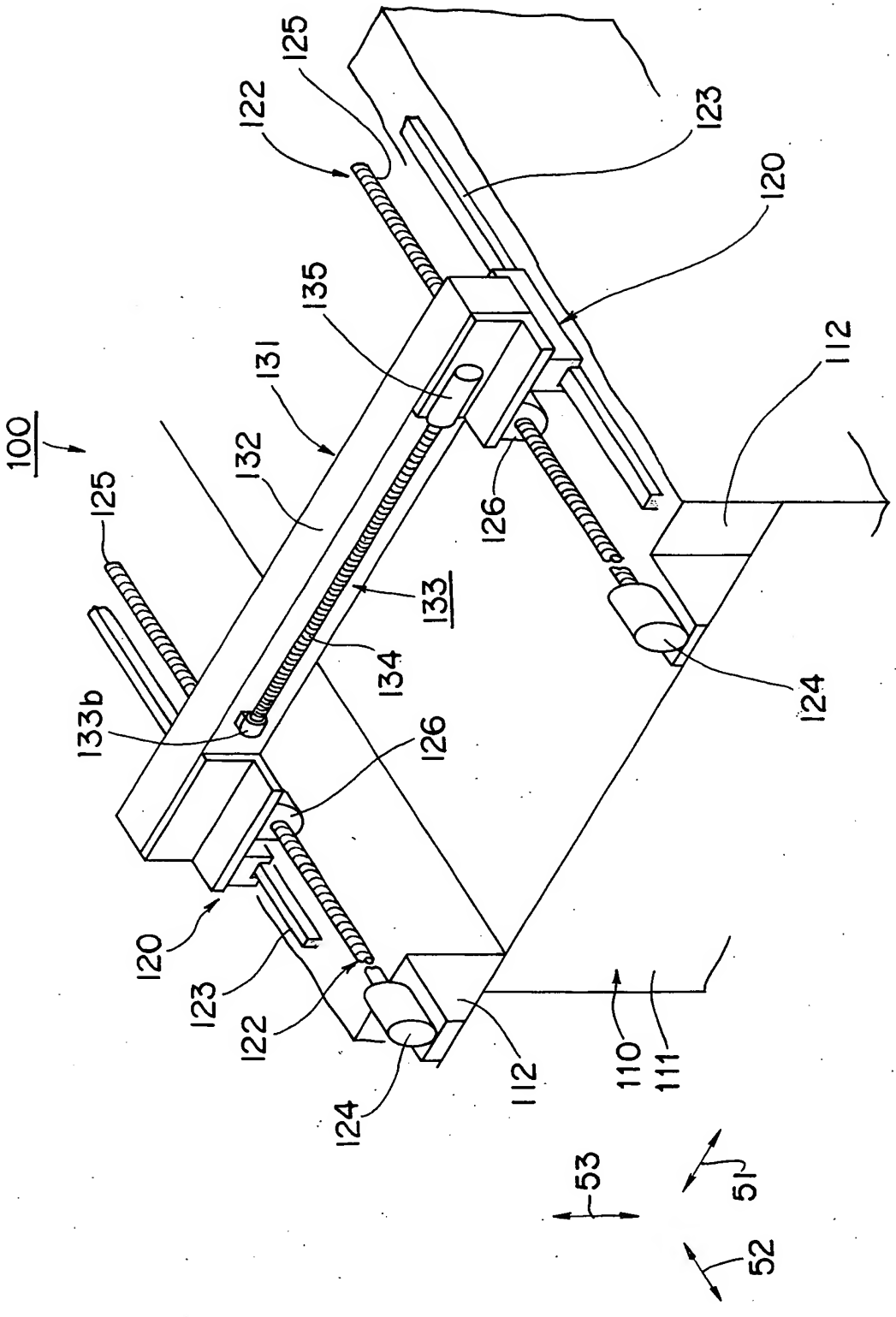

100
125
122
123
120
135
131
132
112
125
126
133
134
133b
124
126
120
123
122
124
112
110
111
53
51
52

Fig. 34

Fig. 35

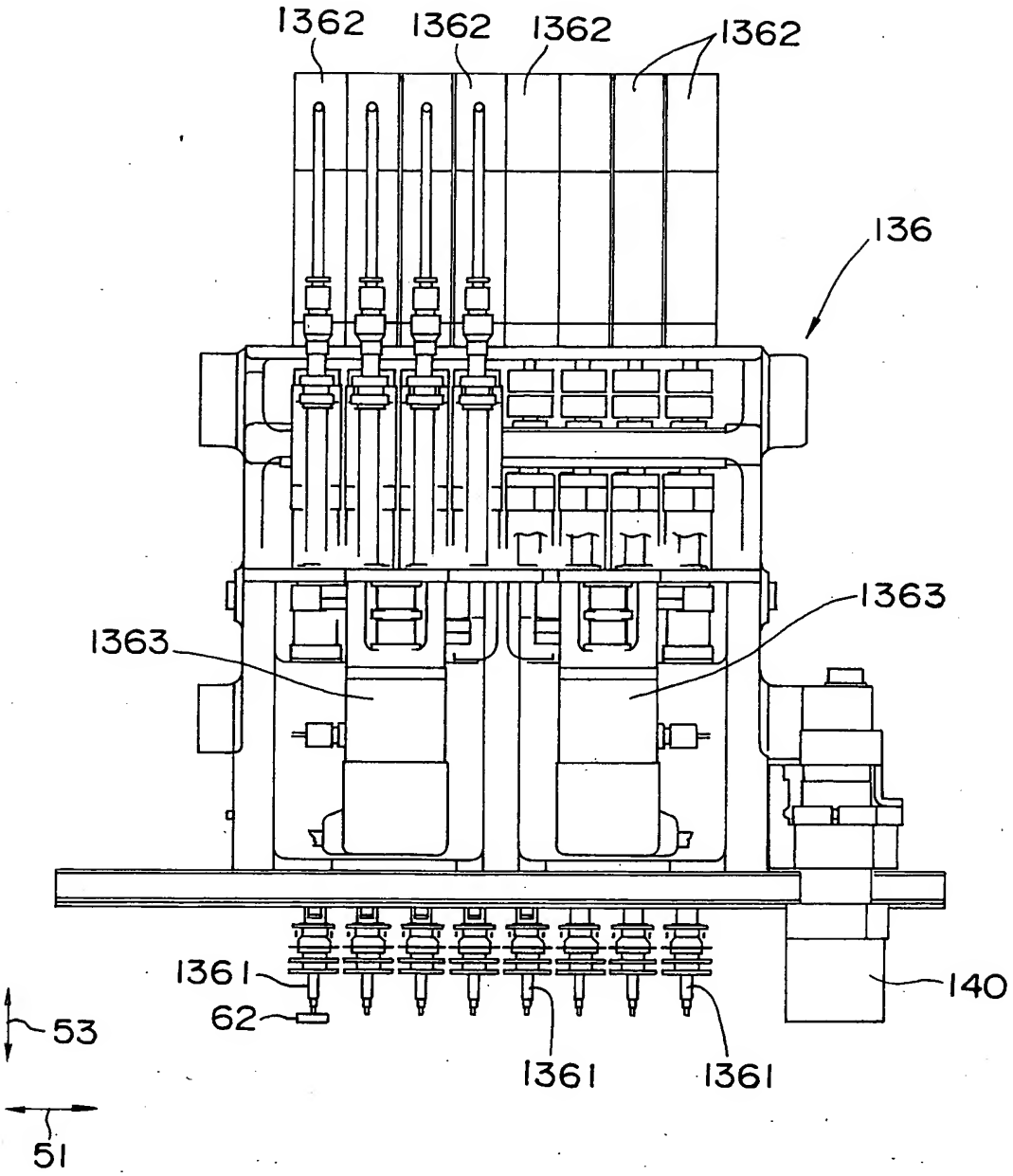


Fig.36

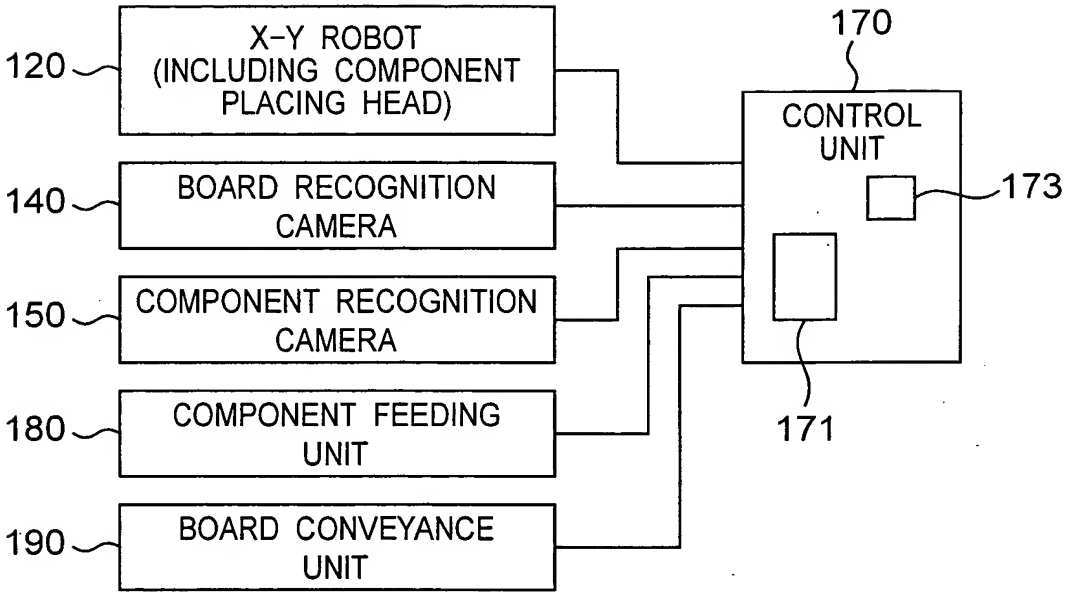

120
X-Y ROBOT (INCLUDING COMPONENT PLACING HEAD)
140
BOARD RECOGNITION CAMERA
150
COMPONENT RECOGNITION CAMERA
180
COMPONENT FEEDING UNIT
190
BOARD CONVEYANCE UNIT
170
CONTROL UNIT
173
171

Fig.37

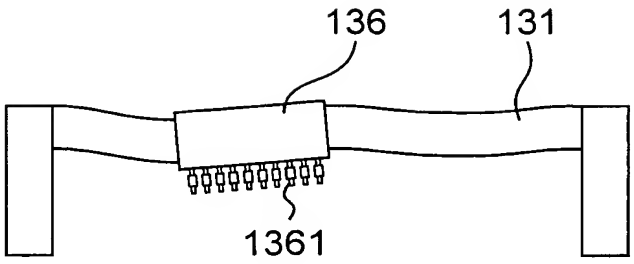


Fig.38

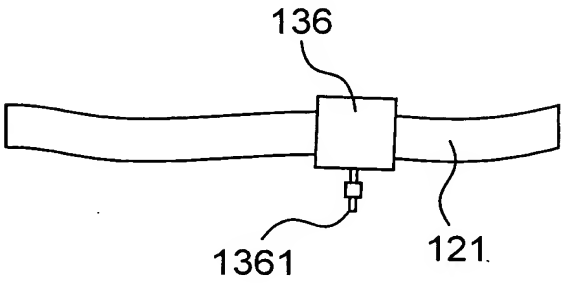


Fig.39

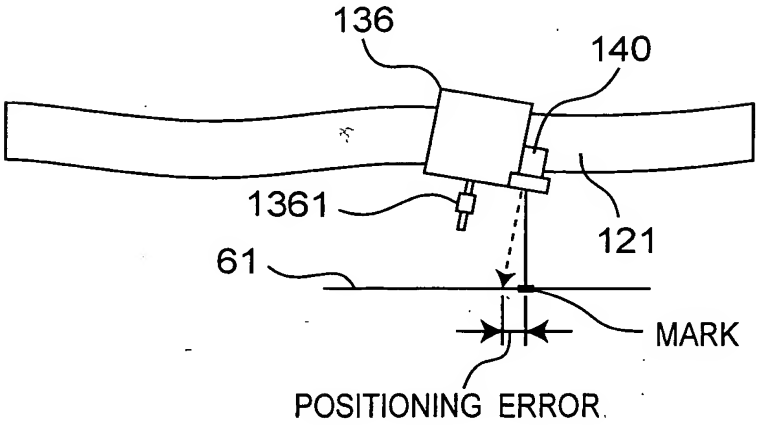


Fig.40

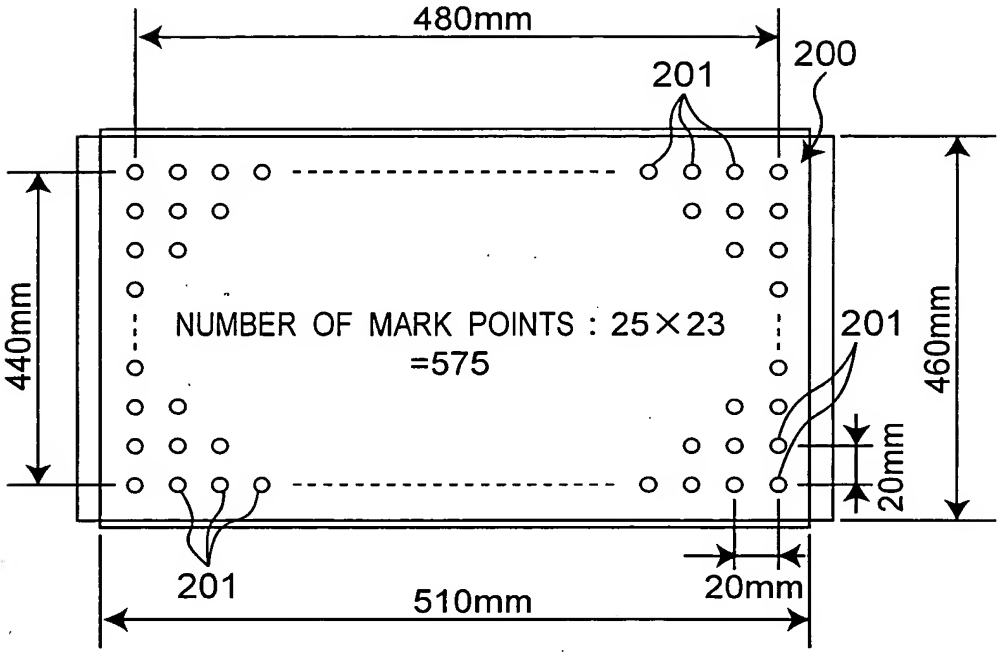

480mm
200
201
440mm
NUMBER OF MARK POINTS : 25×23
=575
201
460mm
20mm
201
510mm
20mm

Fig.41

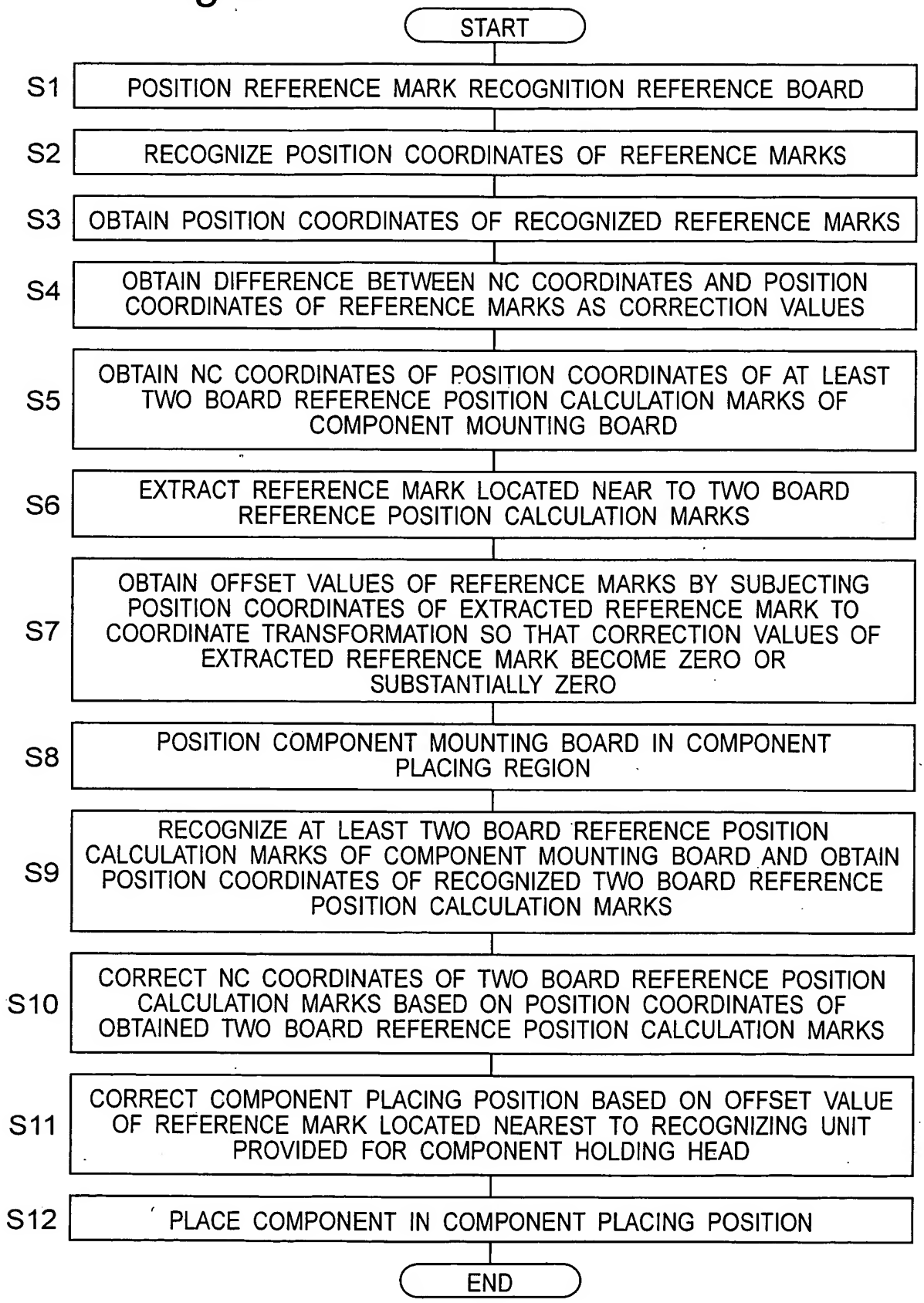

START
S1
POSITION REFERENCE MARK RECOGNITION REFERENCE BOARD
S2
RECOGNIZE POSITION COORDINATES OF REFERENCE MARKS
S3
OBTAIN POSITION COORDINATES OF RECOGNIZED REFERENCE MARKS
S4
OBTAIN DIFFERENCE BETWEEN NC COORDINATES AND POSITION COORDINATES OF REFERENCE MARKS AS CORRECTION VALUES
S5
OBTAIN NC COORDINATES OF POSITION COORDINATES OF AT LEAST TWO BOARD REFERENCE POSITION CALCULATION MARKS OF COMPONENT MOUNTING BOARD
S6
EXTRACT REFERENCE MARK LOCATED NEAR TO TWO BOARD REFERENCE POSITION CALCULATION MARKS
S7
OBTAIN OFFSET VALUES OF REFERENCE MARKS BY SUBJECTING POSITION COORDINATES OF EXTRACTED REFERENCE MARK TO COORDINATE TRANSFORMATION SO THAT CORRECTION VALUES OF EXTRACTED REFERENCE MARK BECOME ZERO OR SUBSTANTIALLY ZERO
S8
POSITION COMPONENT MOUNTING BOARD IN COMPONENT PLACING REGION
S9
RECOGNIZE AT LEAST TWO BOARD REFERENCE POSITION CALCULATION MARKS OF COMPONENT MOUNTING BOARD AND OBTAIN POSITION COORDINATES OF RECOGNIZED TWO BOARD REFERENCE POSITION CALCULATION MARKS
S10
CORRECT NC COORDINATES OF TWO BOARD REFERENCE POSITION CALCULATION MARKS BASED ON POSITION COORDINATES OF OBTAINED TWO BOARD REFERENCE POSITION CALCULATION MARKS
S11
CORRECT COMPONENT PLACING POSITION BASED ON OFFSET VALUE OF REFERENCE MARK LOCATED NEAREST TO RECOGNIZING UNIT PROVIDED FOR COMPONENT HOLDING HEAD
S12
PLACE COMPONENT IN COMPONENT PLACING POSITION
END

Fig. 42

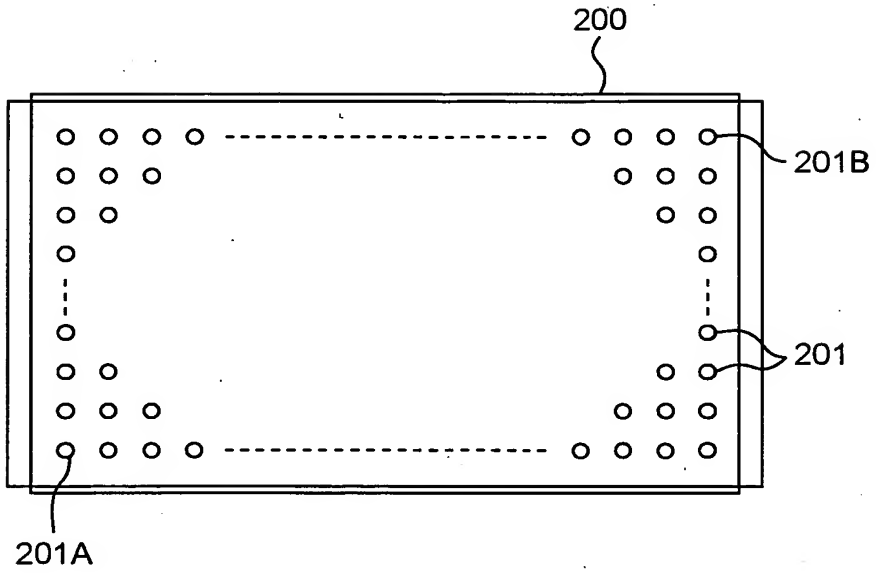


Fig. 43

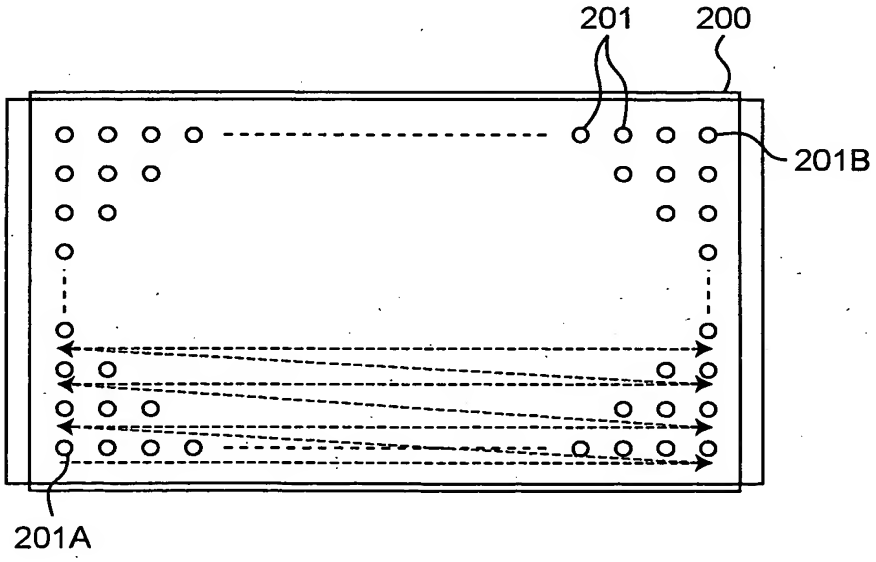


Fig.44

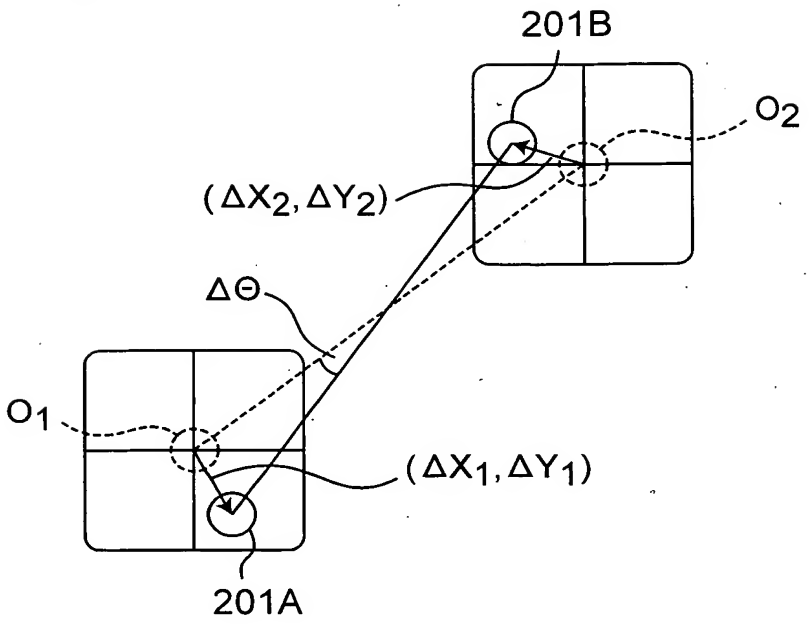

201B
O2
(ΔX2, ΔY2)
ΔΘ
O1
(ΔX1, ΔY1)
201A

Fig.45

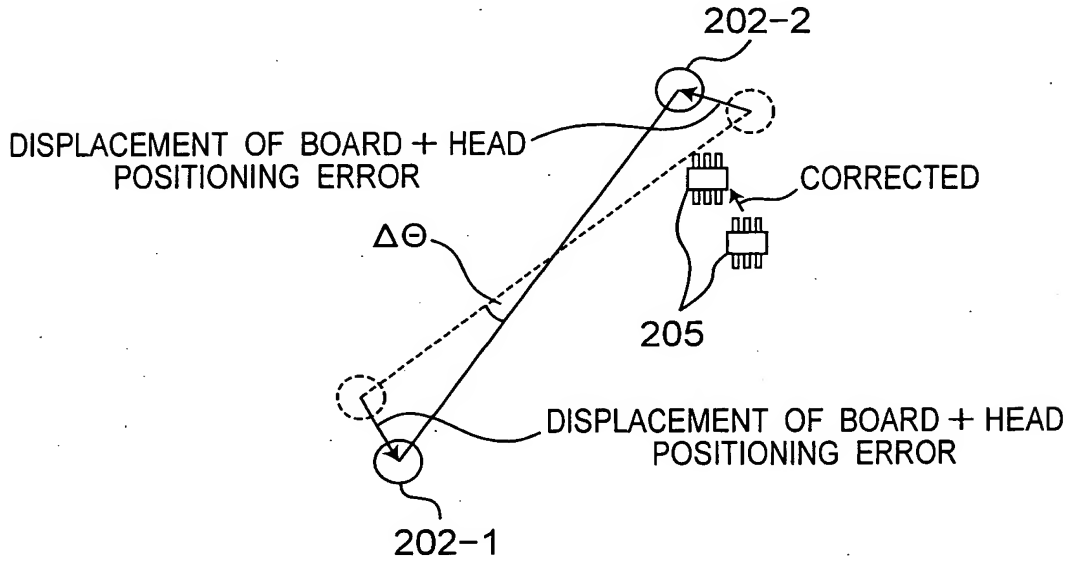

202-2
DISPLACEMENT OF BOARD + HEAD POSITIONING ERROR
CORRECTED
ΔΘ
205
DISPLACEMENT OF BOARD + HEAD POSITIONING ERROR
202-1

Fig. 46

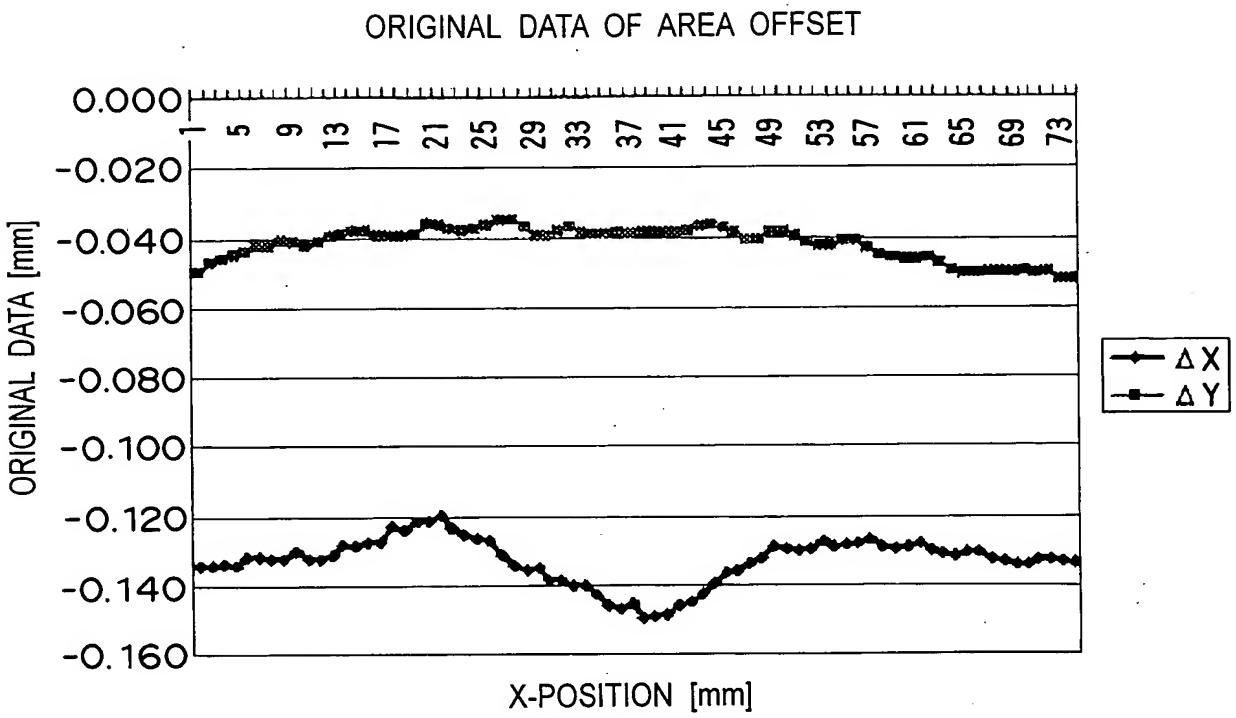

ORIGINAL DATA OF AREA OFFSET
0.000
-0.020
-0.040
-0.060
-0.080
-0.100
-0.120
-0.140
-0.160
ORIGINAL DATA [mm]
1
5
9
13
17
21
25
29
33
37
41
45
49
53
57
61
65
69
73
X-POSITION [mm]
ΔX
ΔY

Fig. 47

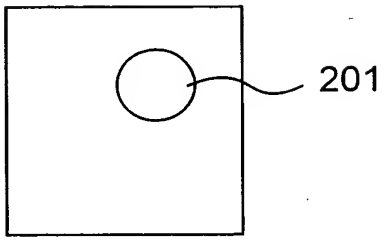


Fig.48

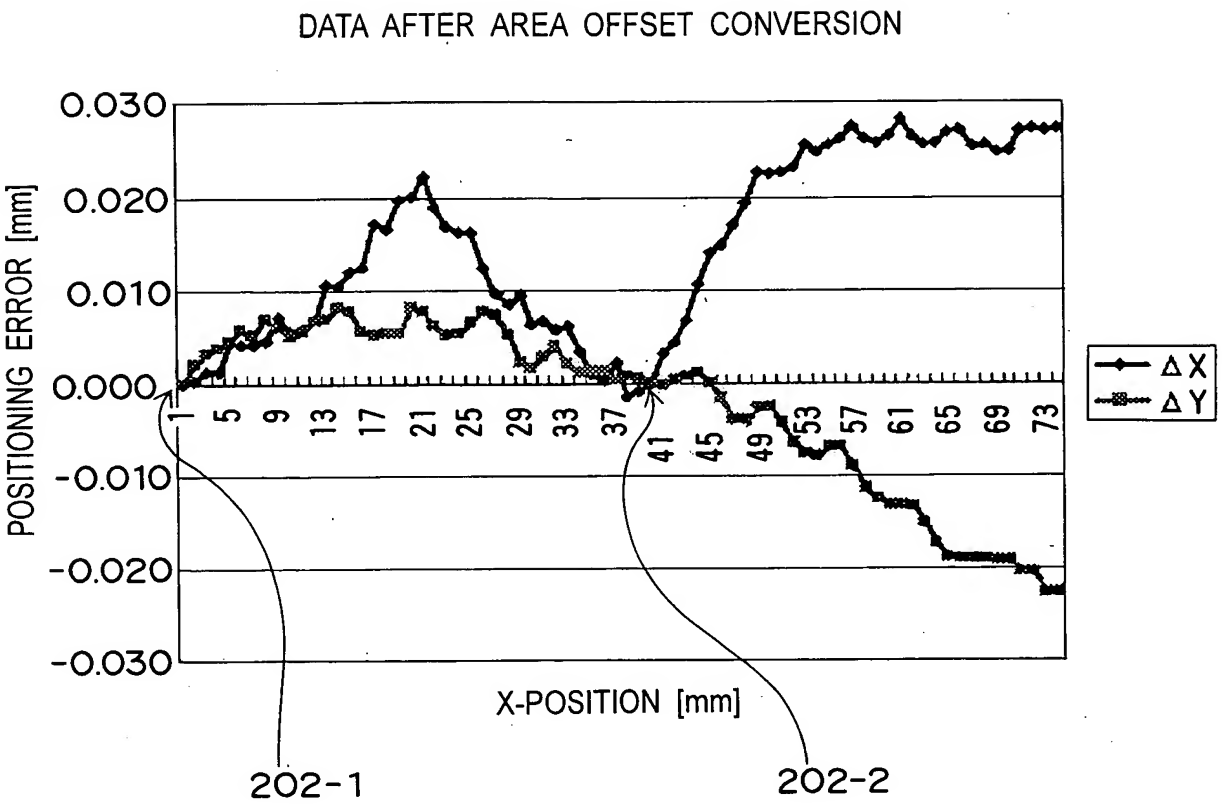

DATA AFTER AREA OFFSET CONVERSION
POSITIONING ERROR [mm]
0.030
0.020
0.010
0.000
-0.010
-0.020
-0.030
1
5
9
13
17
21
25
29
33
37
41
45
49
53
57
61
65
69
73
X-POSITION [mm]
ΔX
ΔY
202-1
202-2

Fig. 49

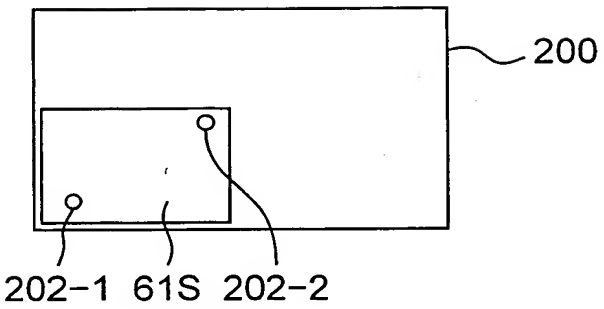


Fig.50

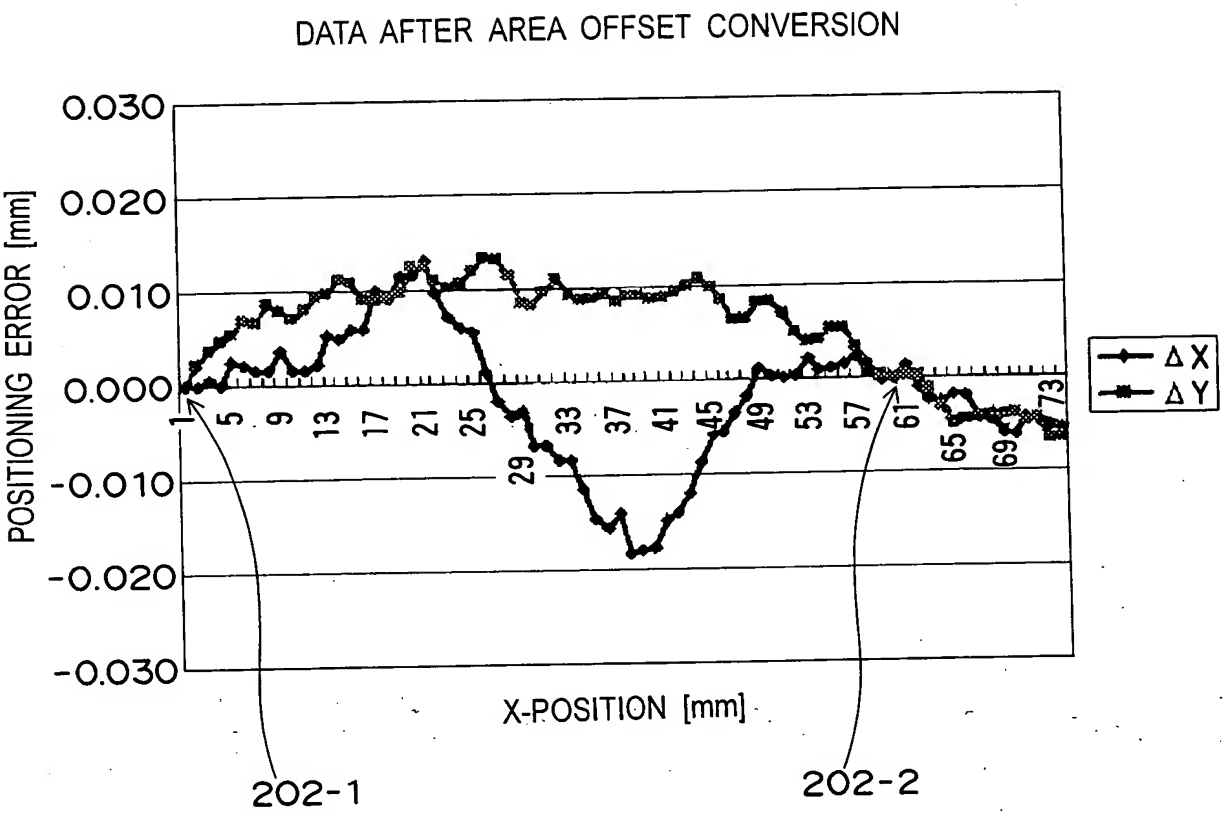

DATA AFTER AREA OFFSET CONVERSION
POSITIONING ERROR [mm]
0.030
0.020
0.010
0.000
-0.010
-0.020
-0.030
1
5
9
13
17
21
25
29
33
37
41
45
49
53
57
61
65
69
73
X-POSITION [mm]
ΔX
ΔY
202-1
202-2

Fig. 51

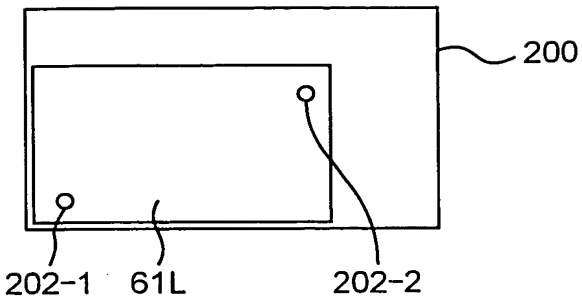


Fig. 52

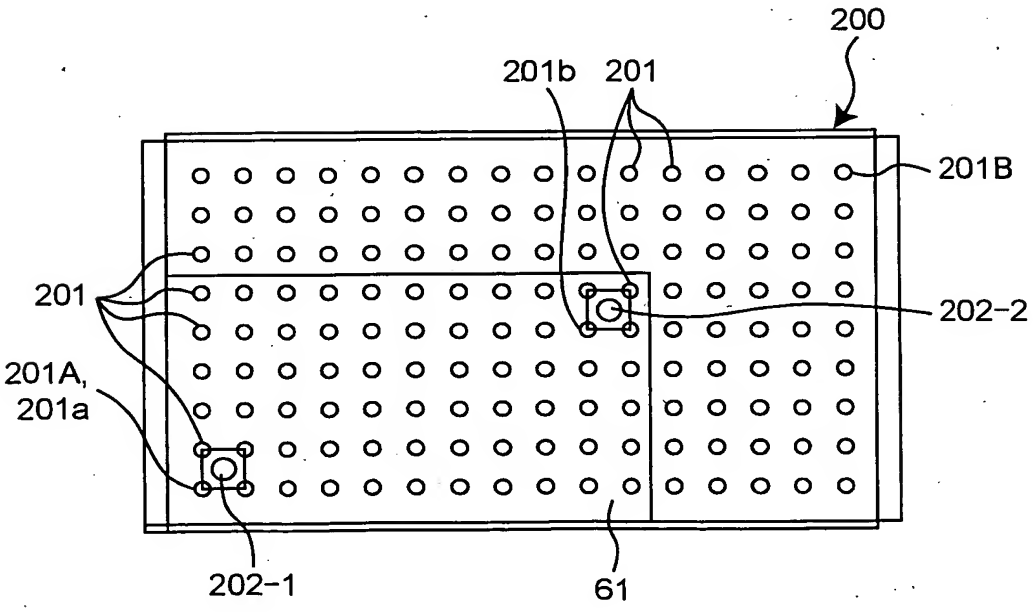


Fig.53

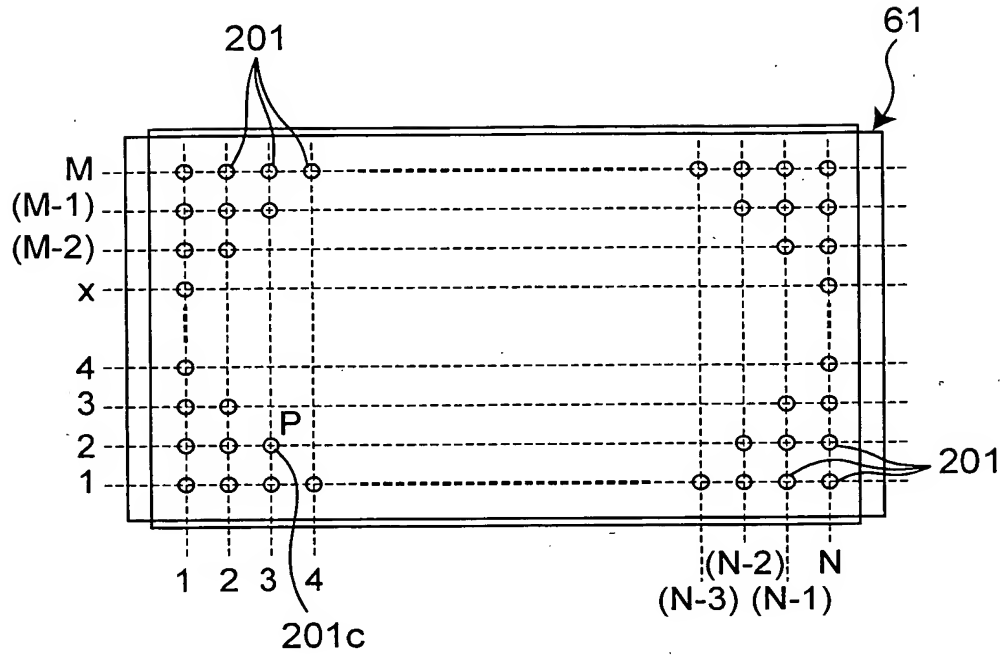

201
61
M
(M-1)
(M-2)
x
4
3
2
1
P
201
1
2
3
4
(N-2)
N
(N-3)
(N-1)
201c

Fig.54

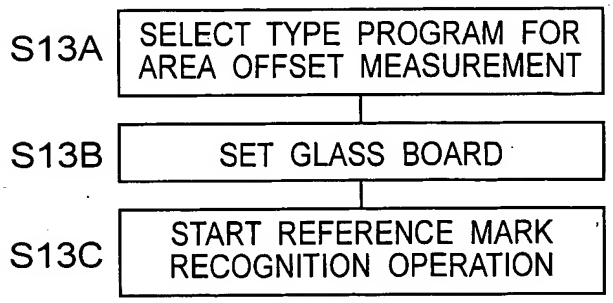

S13A
SELECT TYPE PROGRAM FOR AREA OFFSET MEASUREMENT
S13B
SET GLASS BOARD
S13C
START REFERENCE MARK RECOGNITION OPERATION

Fig.55

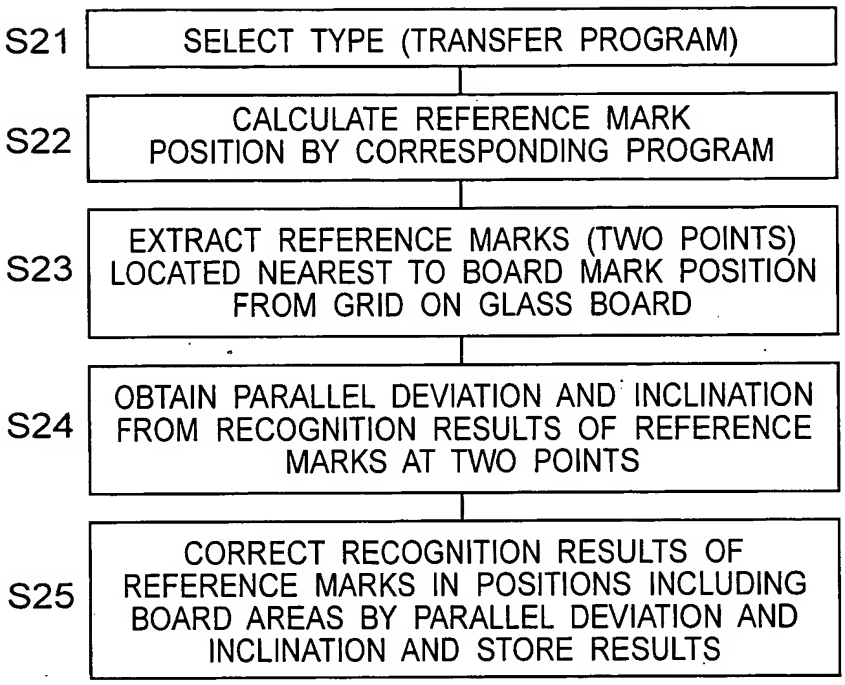

S21
SELECT TYPE (TRANSFER PROGRAM)
S22
CALCULATE REFERENCE MARK POSITION BY CORRESPONDING PROGRAM
S23
EXTRACT REFERENCE MARKS (TWO POINTS) LOCATED NEAREST TO BOARD MARK POSITION FROM GRID ON GLASS BOARD
S24
OBTAIN PARALLEL DEVIATION AND INCLINATION FROM RECOGNITION RESULTS OF REFERENCE MARKS AT TWO POINTS
S25
CORRECT RECOGNITION RESULTS OF REFERENCE MARKS IN POSITIONS INCLUDING BOARD AREAS BY PARALLEL DEVIATION AND INCLINATION AND STORE RESULTS

Fig.56

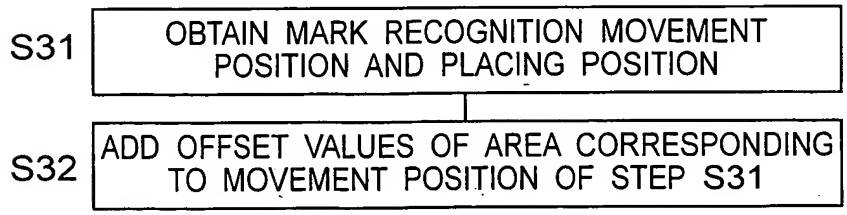

S31
OBTAIN MARK RECOGNITION MOVEMENT POSITION AND PLACING POSITION
S32
ADD OFFSET VALUES OF AREA CORRESPONDING TO MOVEMENT POSITION OF STEP S31

Fig. 57

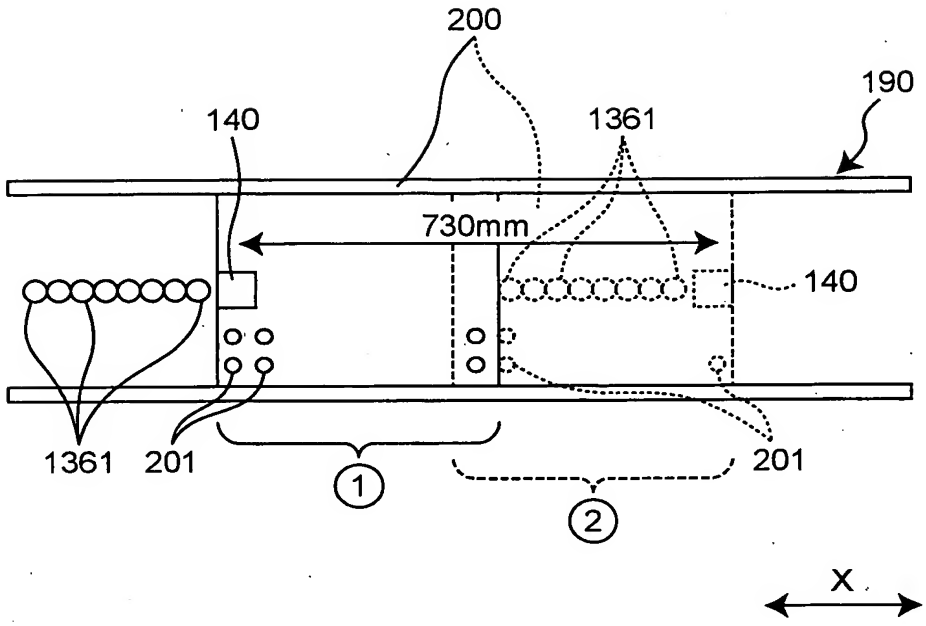


Fig.58

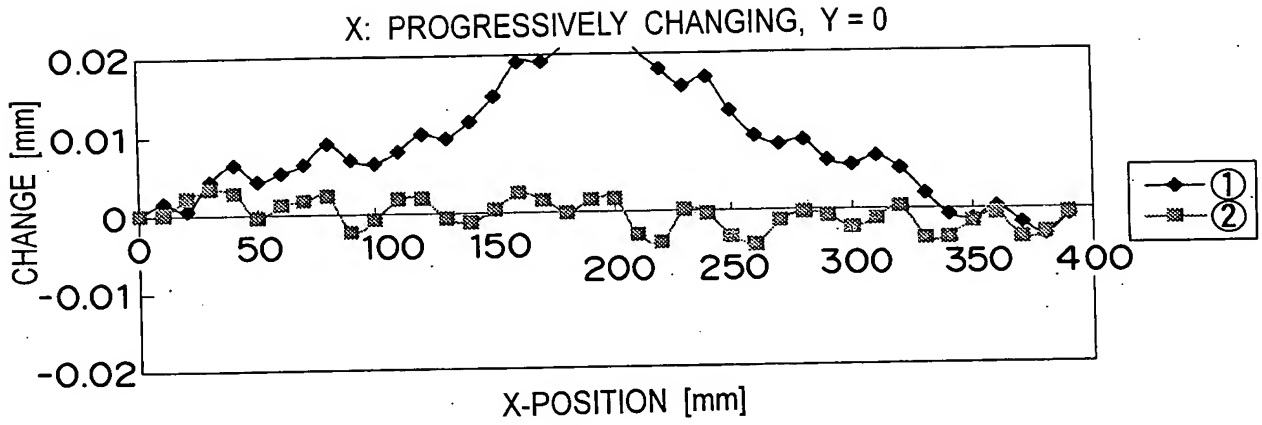

X: PROGRESSIVELY CHANGING, Y = 0
CHANGE [mm]
0.02
0.01
0
-0.01
-0.02
0
50
100
150
200
250
300
350
400
X-POSITION [mm]
①
②

Fig.59

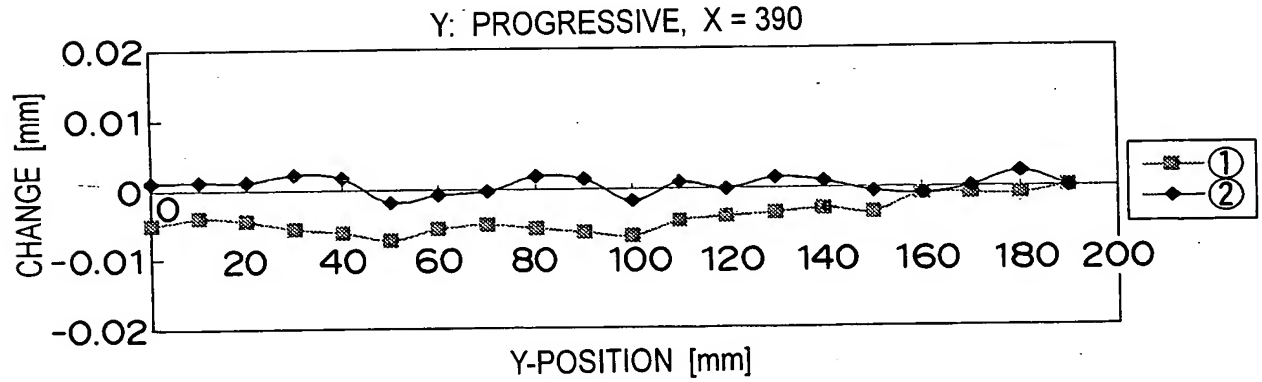

Y: PROGRESSIVE, X = 390
CHANGE [mm]
0.02
0.01
0
-0.01
-0.02
0
20
40
60
80
100
120
140
160
180
200
Y-POSITION [mm]
①
②

Fig.60

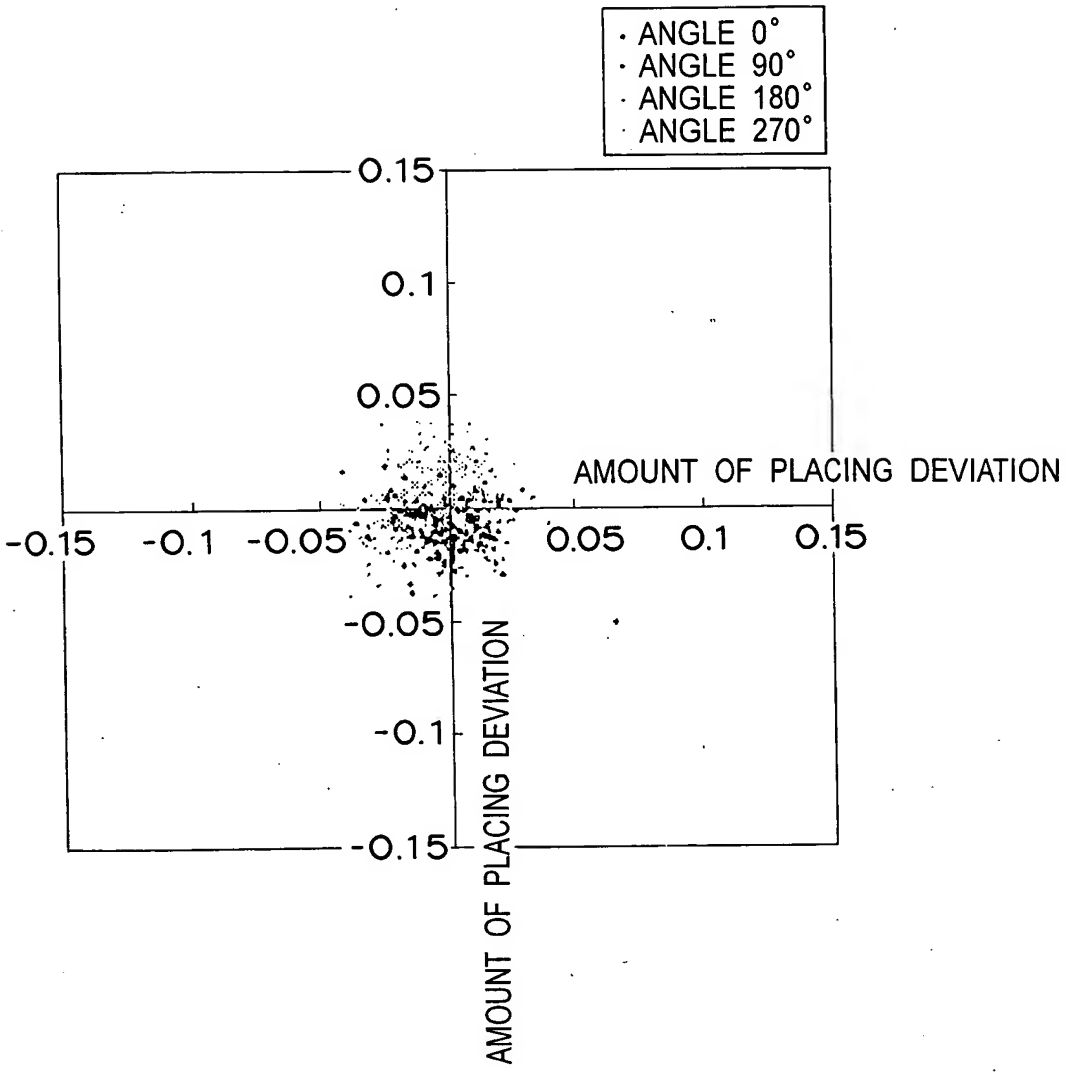

· ANGLE 0°
· ANGLE 90°
· ANGLE 180°
· ANGLE 270°
0.15
0.1
0.05
-0.05
-0.1
-0.15
-0.15
-0.1
-0.05
0.05
0.1
0.15
AMOUNT OF PLACING DEVIATION
AMOUNT OF PLACING DEVIATION

Fig.61

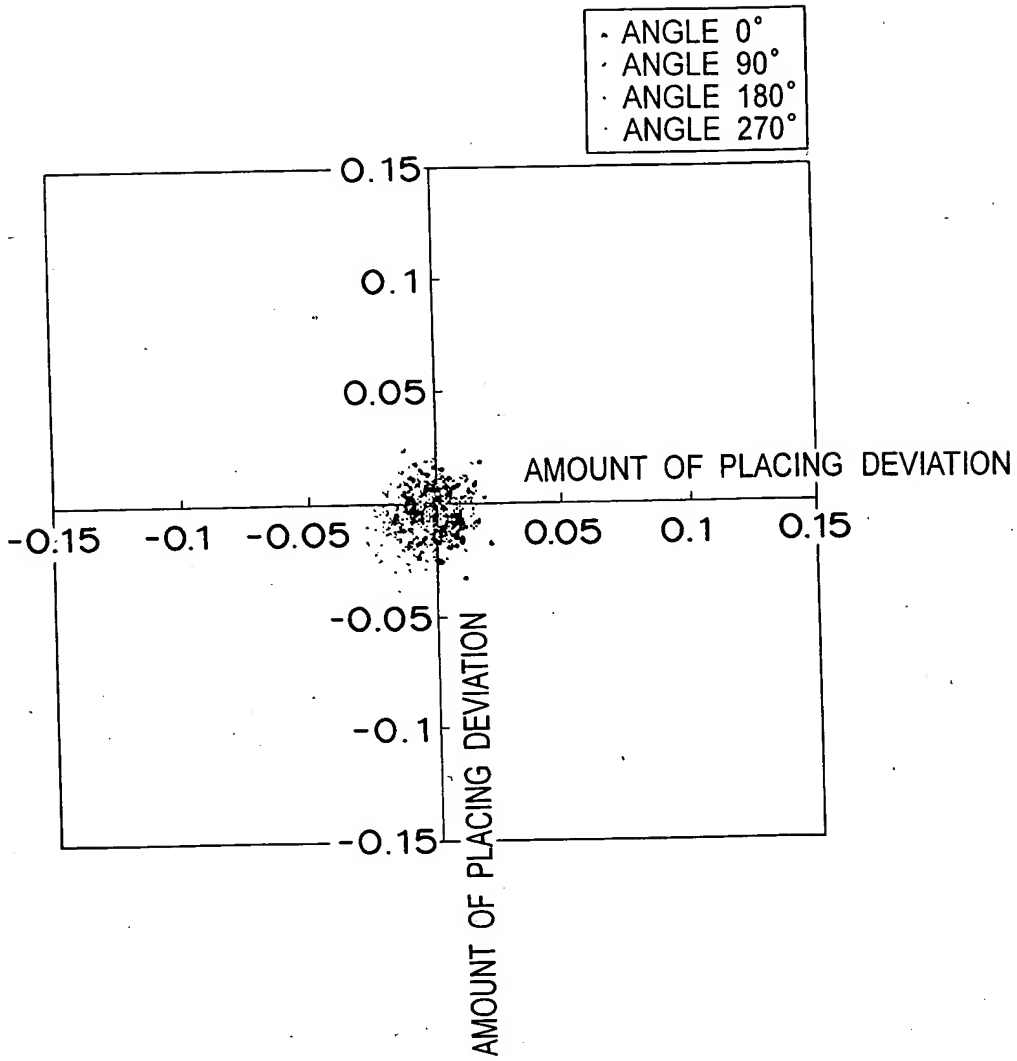

ANGLE 0°
ANGLE 90°
ANGLE 180°
ANGLE 270°
0.15
0.1
0.05
-0.15
-0.1
-0.05
0.05
0.1
0.15
-0.05
-0.1
-0.15
AMOUNT OF PLACING DEVIATION
AMOUNT OF PLACING DEVIATION

Fig.62

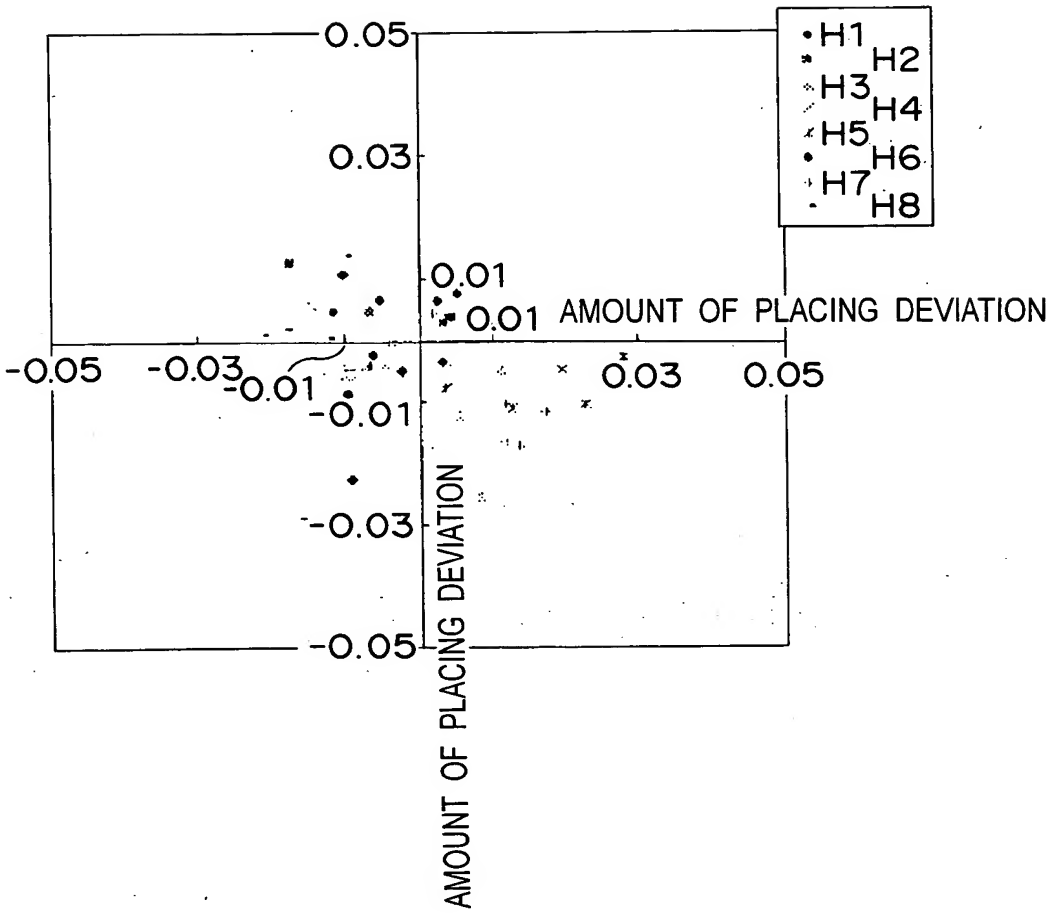

0.05
0.03
0.01
0.01
-0.05
-0.03
-0.01
-0.01
0.03
0.05
-0.03
-0.05
AMOUNT OF PLACING DEVIATION
AMOUNT OF PLACING DEVIATION
H1
H2
H3
H4
H5
H6
H7
H8

Fig.63

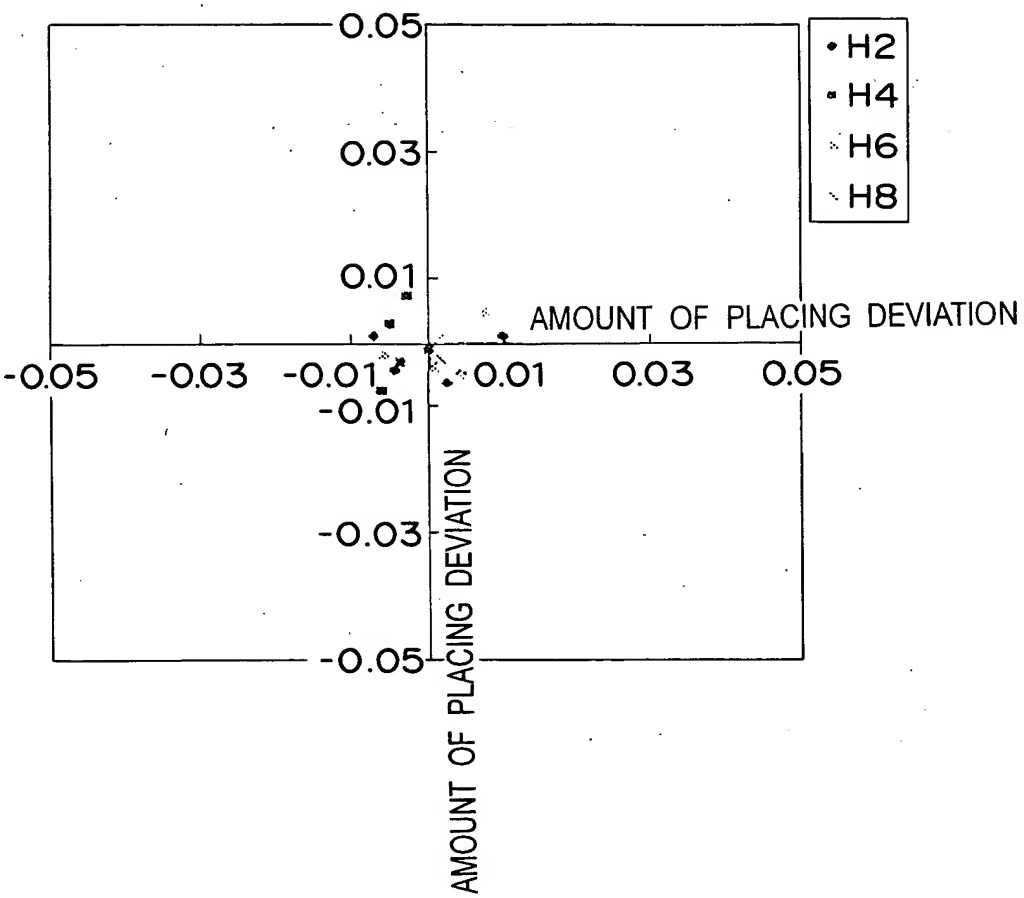

0.05
0.03
0.01
-0.01
-0.03
-0.05
-0.05
-0.03
-0.01
0.01
0.03
0.05
AMOUNT OF PLACING DEVIATION
AMOUNT OF PLACING DEVIATION
H2
H4
H6
H8

Fig.64

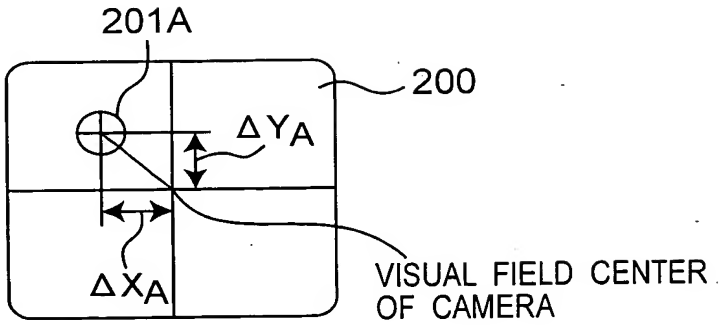


Fig.65

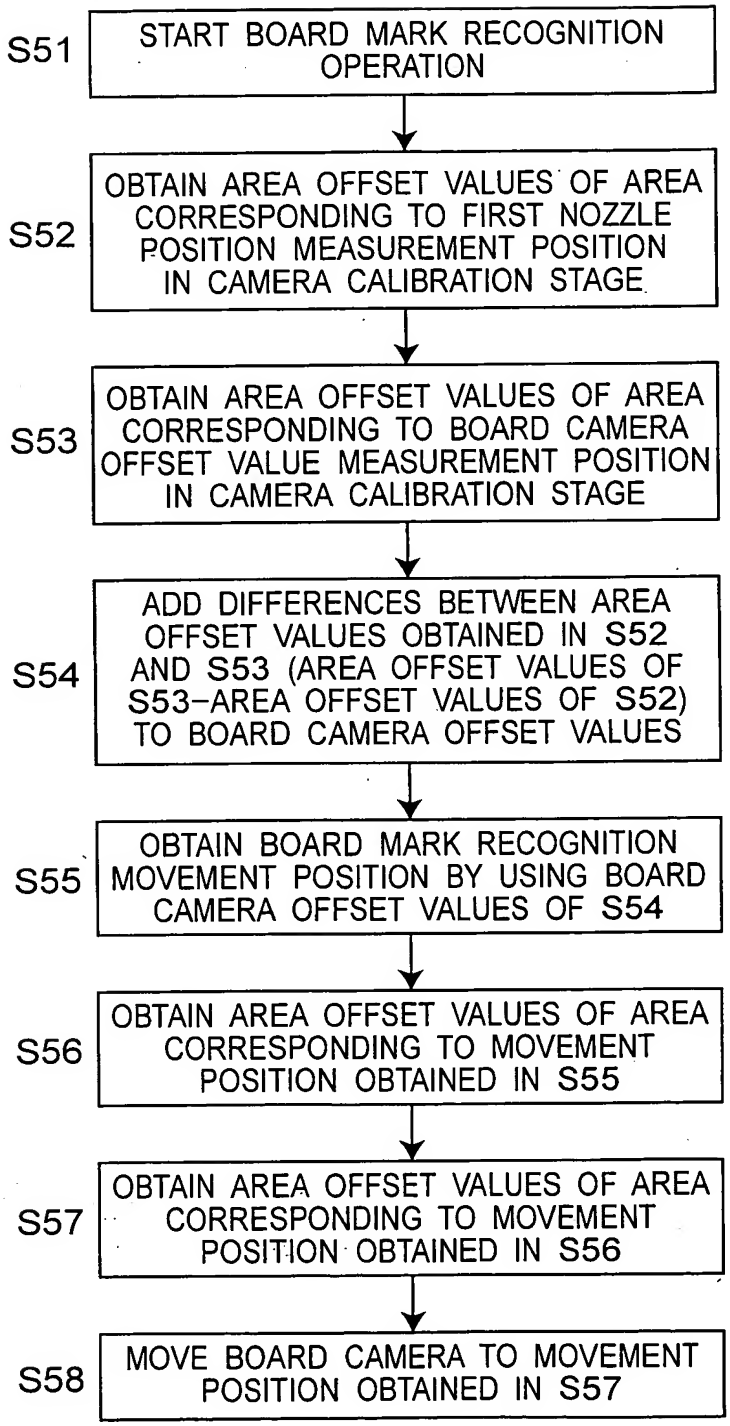

S51
START BOARD MARK RECOGNITION OPERATION
S52
OBTAIN AREA OFFSET VALUES OF AREA CORRESPONDING TO FIRST NOZZLE POSITION MEASUREMENT POSITION IN CAMERA CALIBRATION STAGE
S53
OBTAIN AREA OFFSET VALUES OF AREA CORRESPONDING TO BOARD CAMERA OFFSET VALUE MEASUREMENT POSITION IN CAMERA CALIBRATION STAGE
S54
ADD DIFFERENCES BETWEEN AREA OFFSET VALUES OBTAINED IN S52 AND S53 (AREA OFFSET VALUES OF S53−AREA OFFSET VALUES OF S52) TO BOARD CAMERA OFFSET VALUES
S55
OBTAIN BOARD MARK RECOGNITION MOVEMENT POSITION BY USING BOARD CAMERA OFFSET VALUES OF S54
S56
OBTAIN AREA OFFSET VALUES OF AREA CORRESPONDING TO MOVEMENT POSITION OBTAINED IN S55
S57
OBTAIN AREA OFFSET VALUES OF AREA CORRESPONDING TO MOVEMENT POSITION OBTAINED IN S56
S58
MOVE BOARD CAMERA TO MOVEMENT POSITION OBTAINED IN S57

Fig.66

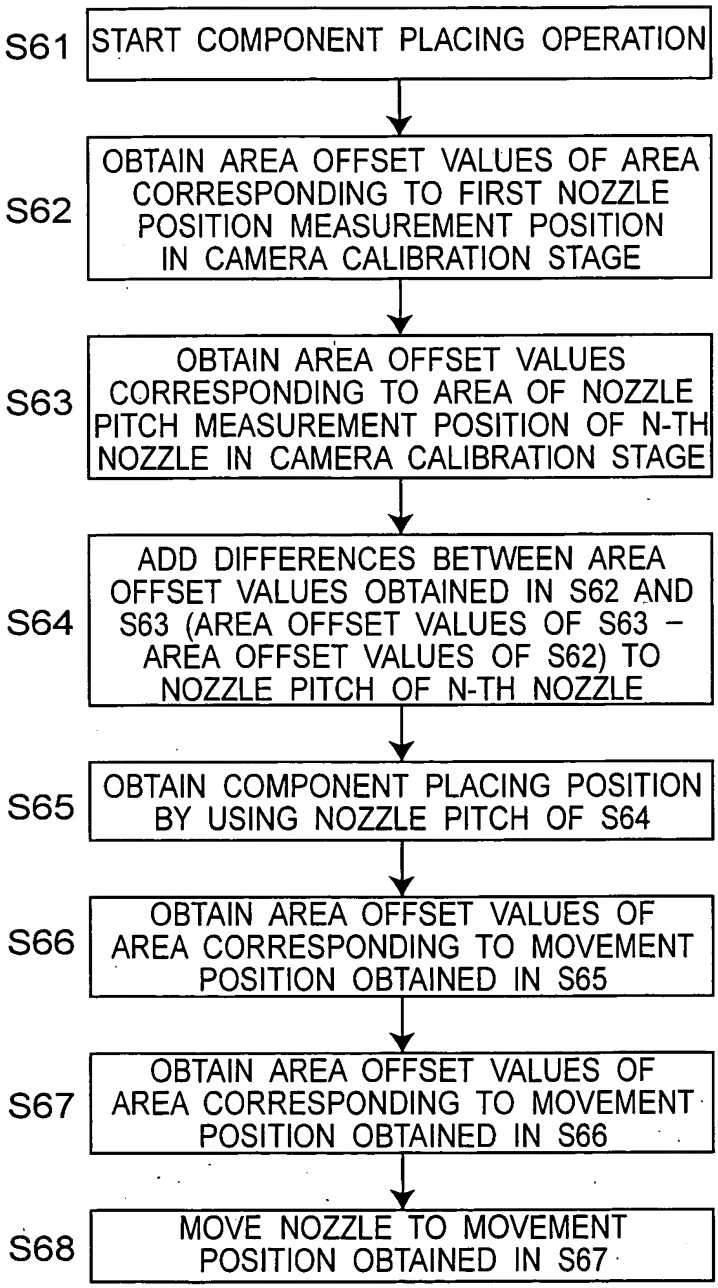

S61
START COMPONENT PLACING OPERATION
S62
OBTAIN AREA OFFSET VALUES OF AREA CORRESPONDING TO FIRST NOZZLE POSITION MEASUREMENT POSITION IN CAMERA CALIBRATION STAGE
S63
OBTAIN AREA OFFSET VALUES CORRESPONDING TO AREA OF NOZZLE PITCH MEASUREMENT POSITION OF N-TH NOZZLE IN CAMERA CALIBRATION STAGE
S64
ADD DIFFERENCES BETWEEN AREA OFFSET VALUES OBTAINED IN S62 AND S63 (AREA OFFSET VALUES OF S63 − AREA OFFSET VALUES OF S62) TO NOZZLE PITCH OF N-TH NOZZLE
S65
OBTAIN COMPONENT PLACING POSITION BY USING NOZZLE PITCH OF S64
S66
OBTAIN AREA OFFSET VALUES OF AREA CORRESPONDING TO MOVEMENT POSITION OBTAINED IN S65
S67
OBTAIN AREA OFFSET VALUES OF AREA CORRESPONDING TO MOVEMENT POSITION OBTAINED IN S66
S68
MOVE NOZZLE TO MOVEMENT POSITION OBTAINED IN S67

Fig. 67A

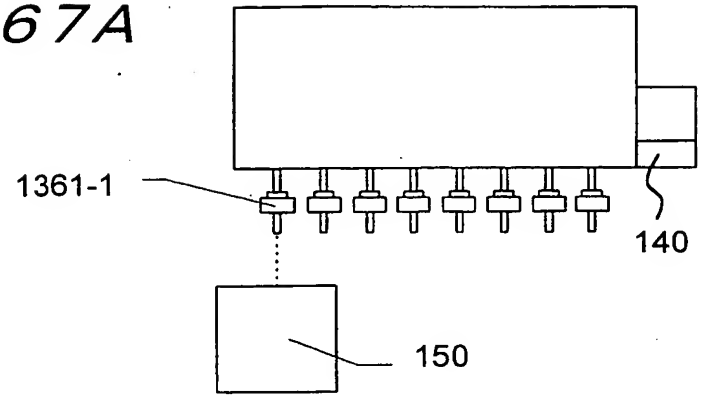


Fig. 67B

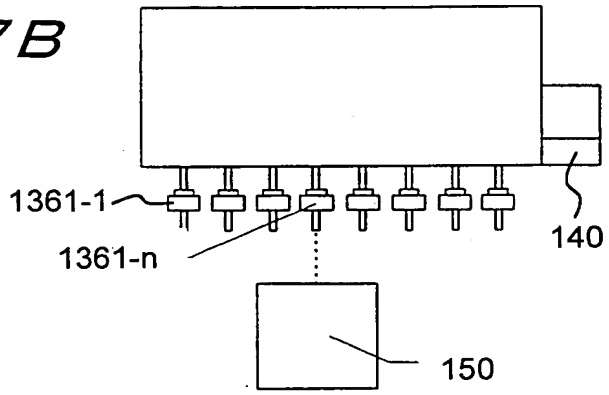


Fig. 67C

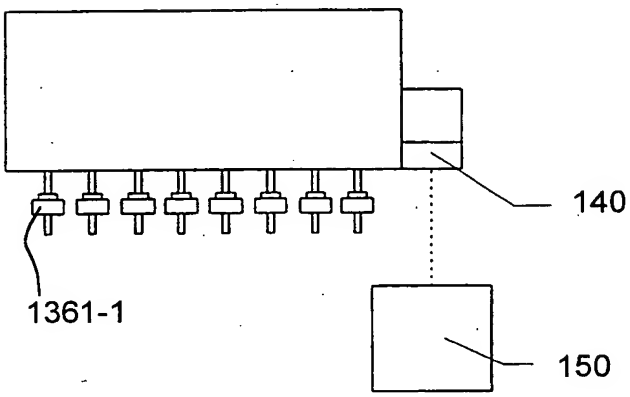
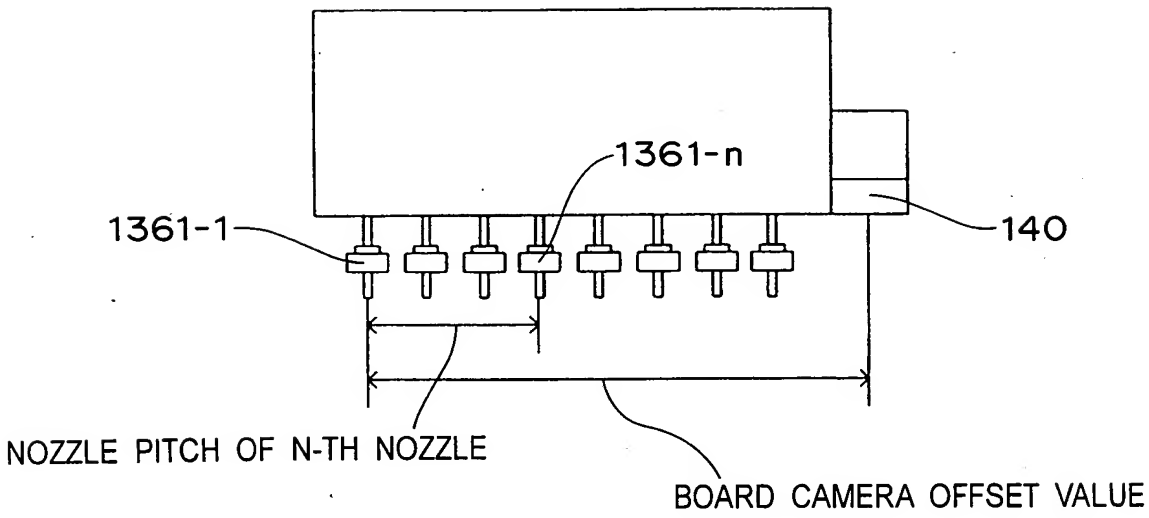


Fig.68


1361-n
1361-1
140
NOZZLE PITCH OF N-TH NOZZLE
BOARD CAMERA OFFSET VALUE